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Managing Seafood Processing Wastewater on the Oregon Coast:

A Time of Transition

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for
Oregon Sea Grant

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Executive Summary

Seafood processors along the Oregon coast practice a wastewater management plan that is unique within the state. Most of these operations discharge wastewater under a General Permit issued by the Oregon Department of Environmental Quality (DEQ) that requires only that they screen the wastewater to remove particles that will not pass through a 40 mesh screen. The General Permit was issued in February of 1992 and was scheduled to expire at the end of December, 1996. It has been extended until a replacement is adopted. Alternatives are currently under consideration by the DEQ.

A second issue is the increasing competition for water within the coastal communities that are experiencing a growing tourist industry and a static water supply. Tourism and seafood processing both have their peak water demands during the summer months when fresh water supplies are most limited.

Disposal of solid wastes has been simplified for many of the processors along the Lower Columbia River by a Fisheries Enhancement Program which allows processors to grind the solid waste then to discharge it into the stream under appropriate tidal conditions. There is no data which indicates water quality damage from this practice nor is there clear evidence of enhanced fishery productivity.

Technologies are available to treat wastewater from the seafood processing industry and to utilize the solid waste materials in a variety of products ranging from pet food to garden compost. None of these uses are of sufficiently high market value, however, to have created a sufficient demand for the amount of solid wastes available during the peak season. The treatment technologies available for the liquid fraction tend to increase both capital and operating costs that are especially threatening to the smaller processors. Alternative less expensive technologies tend to require greater land or floor surface areas for installation. In general, neither is available.

These situations create an opportunity for the Extension Service to be of assistance to this critically important industry by being a source of research based water quality information. The industry will need to base operating decisions on quality data. It will be important that any educational programs be designed to answer questions of importance to the processors. Extension agents and specialists (university faculty members) are available to provide educational assistance to the industry and are not part of the state or federal regulatory programs.

These matters are treated in greater detail in the body and appendices of this report. Interested readers are invited to pursue these items or contact the Extension Service.

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LIST OF ABBREVIATIONS

ABC – Allowable Biological Catch

BAT – Best Available Technology

BOD – Biochemical Oxygen Demand

BOD_5 – Biochemical Oxygen Demand measured using the five day test

BPT – Best Practicable Technology

COD – Chemical Oxygen Demand

DAF – Dissolved Air Floatation

EPA – United States Environmental Protection Agency

MPRSA – Marine Protection Research and Sanctuaries Act of 1972

NMFS – National Marine Fisheries Service

NPDES – National Pollution Discharge Elimination Service

OAR – Oregon Administrative Rules

ODEQ/DEQ – Oregon Department of Environmental Quality

ODF&W – Oregon Department of Fish and Wildlife

OG – Oil and Grease

ORS – Oregon Revised Statute

TSS – Total Suspended Solids

WCFDF – West Coast Fisheries Development Foundation

I. INTRODUCTION

The Oregon Coast is an area rich in beauty and natural resources. The livelihoods of many different groups from the tourist shop owner to the seafood processor depend on this beauty and resource. Issues like water quality and sustaining natural resources are important to the future of these industries and the people who use them. Clean water for consumption, recreation, irrigation, manufacturing, and fish and wildlife habitat are important to Oregonians. Proper management of wastewater from such industries as the seafood industry is needed to maintain clean and usable land and waterways. A major concern of the seafood processing industry is processing byproducts and how their waste streams are affecting the environment surrounding their outfall.

The main purpose of this report is to provide reference material for Extension specialists to assist seafood processors in meeting water pollution requirements. This guide gives general solutions and options for seafood processors in Oregon. It is important to evaluate individual characteristics of seafood processing plant waste systems and the water sources into which they discharge to develop specific solutions.

During the past decade, seafood processors conducted their operations under the authority of the General Permit issued by the Oregon Department of Environmental Quality(DEQ). That General Permit expired January 1997, but is effective until it is renewed or replaced. With the recent expiration of the General Permit for Seafood Processors in Oregon state and increased awareness of water quality issues, there is a need to look at what the future holds for seafood processing waste streams and what we can all do to prepare for these eminent changes. This report will inventory current seafood processing waste disposal practices in Oregon, and then, project these practices into current and anticipated changes to the state and federal regulatory limits. Ultimately, this study will identify the appropriate responses by the Oregon State University Sea Grant Extension Service to assist the seafood processing industry in meeting current and anticipated environmental quality requirements.

Seafood processing generates both solid and liquid waste streams. Recent research efforts have been devoted to developing solid waste recovery and disposal techniques. Some of these techniques are being implemented successfully in Oregon. But many of these byproduct recovery techniques are struggling to maintain operation without economically stable markets.

The other aspect of seafood waste which has not gotten as much attention is the issue of wastewater disposal. This paper will try to emphasize the wastewater disposal techniques and current technologies which are available for its cleanup and final disposal.

This document is designed to aid Extension specialists as well as seafood processors to develop effective wastewater and waste control programs, with the goal of meeting water pollution requirements in the future. This information can also aid in bringing together representatives from the seafood industry, regulatory agencies, and the general public to coordinate their mutual interests in wastewater treatment while maintaining the economic health of the seafood industry.

1. Overview:

First, the seafood processing industry on the Oregon coast will be described. Each of the major species processed in Oregon will be looked at in closer detail. This will include a description of waste and waste water characteristics specific to each process. Following this, important water quality parameters for seafood wastewater are described to provide a background for understanding and communication about these characteristics and how they affect natural systems. Solid waste disposal and use will also be discussed. The next section will discuss the regulatory programs currently in place, their origin and the goals behind them. Are these goals being met? The anticipated changes to update the 900J permit in the near future will be looked at to ascertain their effect on seafood processing in Oregon. With this possible change in regulation, it is important to evaluate each plants situation with regard to waste and wastewater discharge and plan for the future, in order to meet standards and continue to process seafood economically. Alternatives to wastewater treatment are described to include their effectiveness

and cost. This section contains information on water use reduction, solid waste disposal, and byproduct recovery alternatives. Finally, a recommendation will be given as to what Extension and or other agencies can do in the future to facilitate the proper disposal and utilization of seafood processing waste and wastewater.

2. Background:

Seafood processing as practiced on the west coast, uses large quantities of water and produces large quantities of solid waste. Depending on the process, as much as 50 gallons of fresh water may be used for each pound of product produced (Claggert 1974). In Oregon, the availability of fresh water is a constraint due to increasing demands for water in areas of population growth. Additionally, the majority of the seafood catch brought into process is not part of the primary product. On average, only 40% of the total weight (round weight) of seafood delivered in to the processor leaves as final product. Typically, seafood processing wastes are high in organic material, oils, and greases. Improperly handled they represent a major oxygen demand and visual impairment on water quality. Another problem seafood processors face is the increasing complexity of wastewater disposal technologies and regulations.

Wastewater treatment and disposal is a relatively new problem for Oregon's seafood processors. There was a time when water use and waste disposal were of little concern to the seafood processor. Seafood processors have historically discharged untreated wastewater directly into coastal waters or estuaries of Oregon. These practices have only recently been re-evaluated and changed. Fishing is less predictable than land based food production. This has created a situation where few markets have developed for seafood byproducts in the United States (Morrissey1996). With the tightening of environmental regulations, decreasing quotas on seafood catch, and budgetary constraints; seafood processors must find a way to remain competitive while maintaining environmental discharge requirements. This is not an easy task. Waste disposal and clean up are becoming more and more expensive. Methods to produce less waste, find other

uses for their byproducts, and to find less expensive/more effective means of wastewater treatment are of major concern to seafood processors.

Seafood processing waste steams can be separated into two different categories, liquid and solid. While some of their characteristics are similar, they are generally dealt with and treated in two different ways. Both of these categories will be discussed in detail.

Water quality regulations as a whole are becoming more and more stringent. This seems to be the trend of regulations for the discharges from seafood processing industries as well. Water use is another constraint for seafood processors due to the increased demand on water consumption from communities with increased population and tourist trade. Increased sensitivity of the general public to water quality and environmental issues is another driving force for future changes.

One question many ask, is whether or not all this regulation is necessary for the seafood industry which has been operating with few regulations for a large part of its existence? What evidence do we have that this is a problem at all? The fisheries enhancement program, which is administered by the Oregon Department of Fish and Wildlife(ODF&W), challenges this idea. This program allows seafood processors to seafood wastes into surrounding waters with the anticipation that it will enhance aquatic communities in the area. There are also numerous cases which support the current program and others which establish a possible need to re-evaluate them.

Few complete and comprehensive studies have been done to understand the effects of seafood processing waste on the environment. Before we are able to fully answer the above questions, there may be a need for more comprehensive site specific studies on the effects of seafood processing waste, both solid and liquid, on water quality.

II. DESCRIPTION OF INDUSTRY

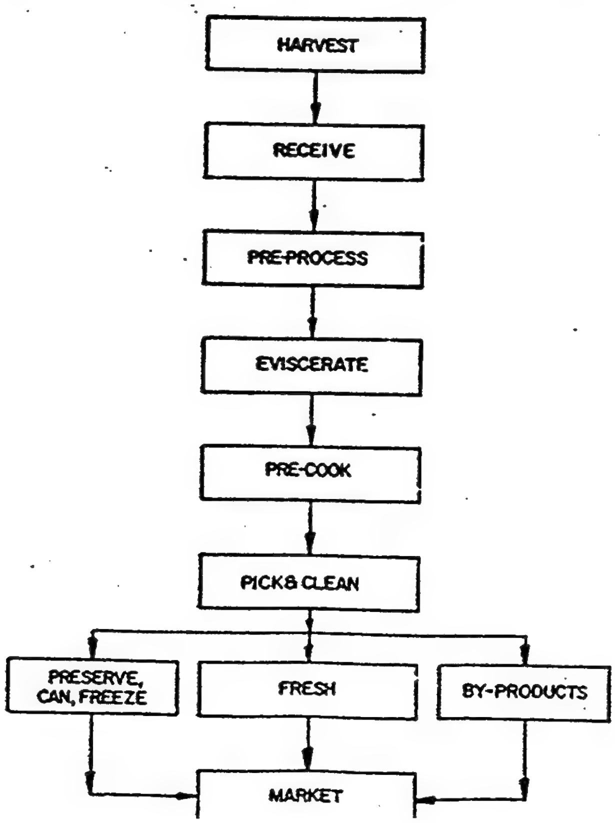
In Oregon, the seafood industry has processors of various sizes ranging from small local producers to large national businesses. Most processing firms are located along the coast. There is one processor located inland in Albany.

Currently, there are approximately 30 primary seafood processors registered with the DEQ for wastewater discharge permits in Oregon. There are also several secondary processors of seafood byproducts (4 fish meal plants, 1 fish hydorlysate plant, 2-3 pet food secondary processing plants, and several composters). Please see Appendix A and B for listings of these processors.

The majority of Oregon's seafood processors are relatively small, low capital investment operations competing in a market dominated by much larger Alaskan processors. Seafood processing is labor intensive. The industry in Oregon is dynamic with frequently changing management and ownership. Oregon's most important seafood products over the past 30 years are groundfish, shrimp, crab, salmon, and tuna (ODF&W 1995). The use of Pacific Whiting/hake for the production of surimi has created a dramatic increase in some companies' production in the past ten years. The seafood industry is seasonal and regulated by strict quotas of the number of each species which can be caught. These quotas are established by the National Marine Fisheries Service and international treaties. The type and amount of seafood and wastes produced vary widely from month to month. A significant portion of seafood processed is "wasted." On average, around 60% of the round catch is not use in the final product (WCFDF 1983). In addition to large volumes of solid waste, seafood processors produce significant volumes of wastewater. These volumes vary depending on the processing method and species being processed. Oregon's harvest has continued to grow with the increasing demand for seafood products. But landings of several species are declining or have remained constant. For example, salmon harvest has declined by 90 percent in the past 20 years (ODF&W 1995). Whiting, shrimp, and crab harvests have been relatively constant over the past several years.

Harvesting is often considered a separate industry which supplies the raw material for processing and distribution. Often times seafood is preprocessed before it is brought into the processor. This may include such actions as deheading shrimp, eviscerating fish or shellfish at sea. The catch is transported to the receiving operations which usually involves unloading the vessel, weighing, and transport to the processing area. The catch may be processed immediately or placed in cold storage. When processed the catch is then eviscerated and or butchered. Wastes from this step are often captured or screened and used in byproducts. Depending on the species and final product, cooking or precooking is used to prepare the seafood for the picking and cleaning operation. The condensate from this process, stickwater, is often collected and used in byproduct recovery. Picking and cleaning separates the edible portions from the non-edible portions. Wastes in this step can be collected for byproduct recovery as well. With fresh product, the meat product is packaged and is refrigerated for shipment. If the product is to be held for an extended period of time, there are several other forms of preservation used to prevent spoilage including freezing, canning, pasteurization and refrigeration. (See Figure 1)

Figure 1. Flow Diagram of a General Seafood Processing Operation (EPA 1975)



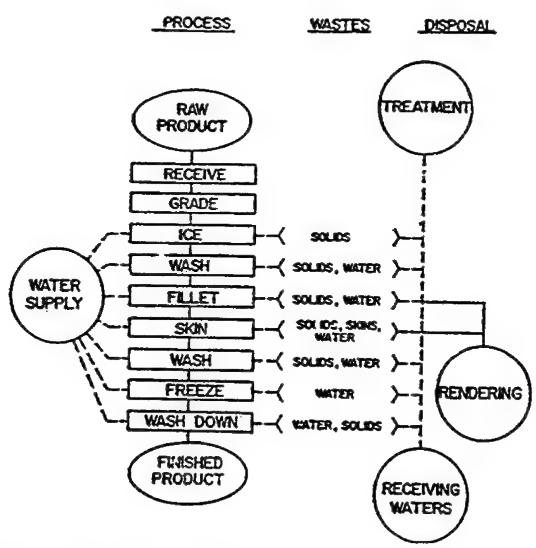
1. Species:

Each of the major categories of seafood produced in Oregon are detailed below.

a. Bottomfish

Bottomfish are Oregon's largest seafood product. Another name for this group of fish is groundfish. This category encompasses such species as halibut, lingcod, Pacific cod, rockfish, sole, haddock, pollock, flounder, and Pacific Whiting(hake). The catch of groundfish in Oregon has remained steady with small increases the past ten years. Bottom fish are normally filleted (See Figure 2). During this process, fish are filleted, headed, gutted, washed, and immediately iced for distribution. Many plants use mechanized equipment in this process. First, the fish are washed, then they pass through a filleting machine or tables. Water use is relatively low for hand filleting operations as compared to surimi or mechanized filleting processes. Groundfish solid byproducts can be used for the production of fish meal. Most plants in Oregon will distribute their bottomfish wastes to the fish meal plants when and where available.

Figure 2. Flow Diagram of a Typical Filleting Process

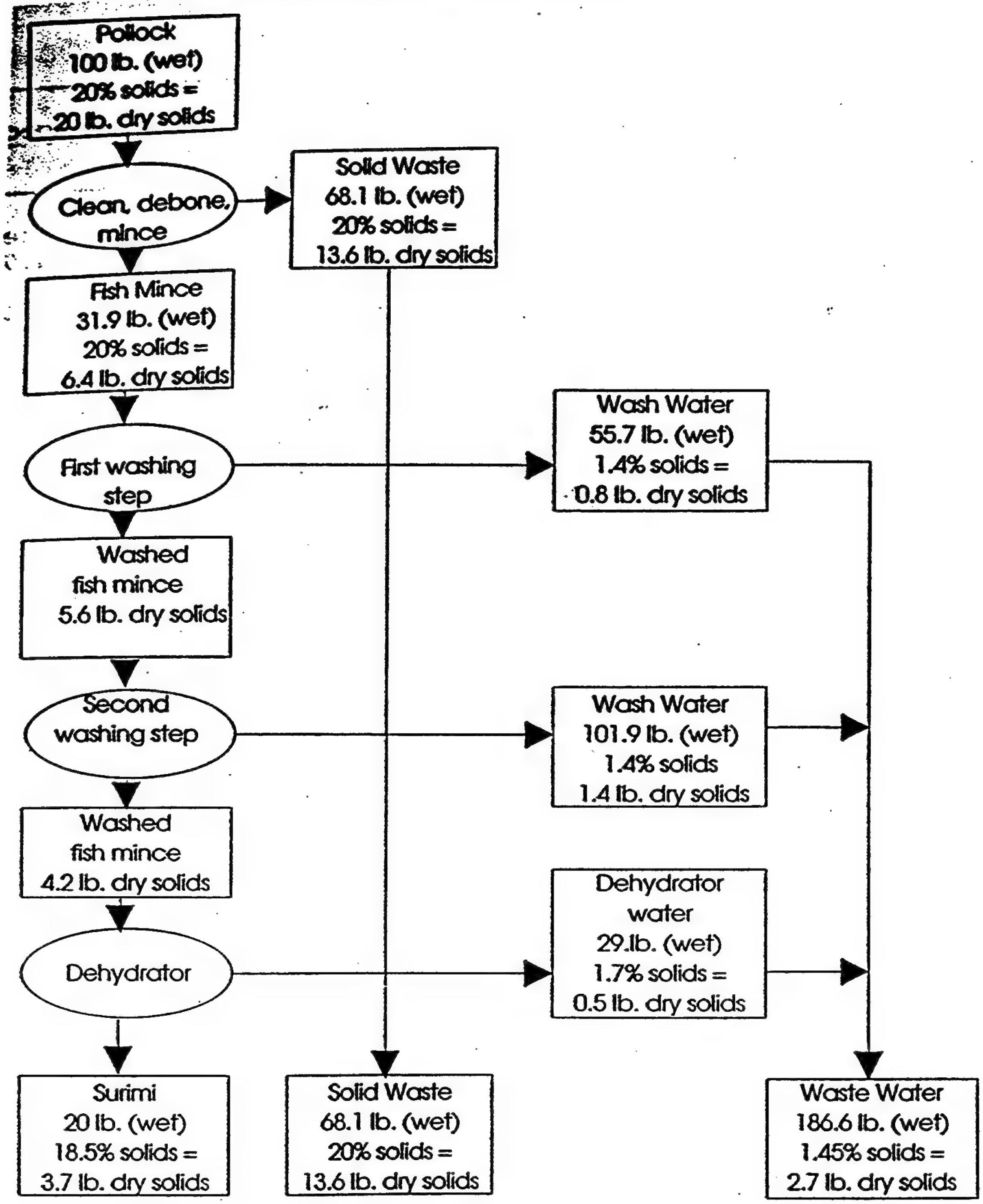


Source: EPA Report 12060-04/70

b. Whiting / Surimi

The Pacific Whiting, formerly of little interest to the seafood industry, is currently one of Oregon's largest catches because of its use in surimi production. It is classified as a bottomfish, but because of its size, unique processing, and impact on Oregon's seafood production, it is often considered separately. Surimi is a concentrate of the myofibrillar proteins of the Pacific Whiting, most commonly used as imitation crab meat. This is a fairly new product in the United States, and was first produced on the Oregon coast in the early 1990s. According to Mike Morrissey, of the Oregon State University Seafood Laboratory, the whiting industry production has recently leveled off due to quotas on the number of fish that can be landed. These strict quotas on catch are determined by the National Marine Fisheries Service which define the allowable biological catch(ABC) based on international agreements and studies. Dr. Morrissey foresees no future increase in the production of surimi in the near future. The Pacific Whiting season generally lasts from 3 to 6 months, May to September. The whiting are headed and gutted, ground, washed, and de-watered several times to remove unwanted materials. Washing and dewatering produces a 30-40% loss of proteins (Pederson 1990) creating waste streams with high TSS and BOD. Processing of Surimi also uses large amounts of water. According to Dr. Morrissey, for every 100 lbs. of whiting, you only get 17 to 20 lbs. of surimi.(Hinkamp 1996). Figure 3 represents the flow diagram for surimi processing. Water use and waste production are especially high for this process. Due to the large amount of surimi being possessed, there has been a push that Oregon's general permit for seafood processing waste water discharge (900J) is not sufficient to regulate wastewater discharge from surimi producers. Some of the larger surimi operations are being regulated by individual National Pollution Discharge Elimination System (NPDES) permits specific to each processor. These permits are generally more detailed and require more monitoring than the General Permit issued by the Oregon Department of Environmental Quality.

Figure 3. Flow Diagram for a Typical Surimi Production Operation



% Recovery	18.4	68.1		13.5
Product	Surimi (w/ 8% additives)	Fish meal (2% moisture)		Recoverd Protein (no additives)
% Solids	24.5	93		18.5
Wet Weight	21.6 lb.	14.6 lb.	14.6 lb.	

Source: Pedersen, L.D. Product Recovery From Surimi Wash Water in "Making Profits out of Seafood Wastes; Proceedings of the Internationa Conference on Fish By-Products, Anchorage, Alaska 1990.

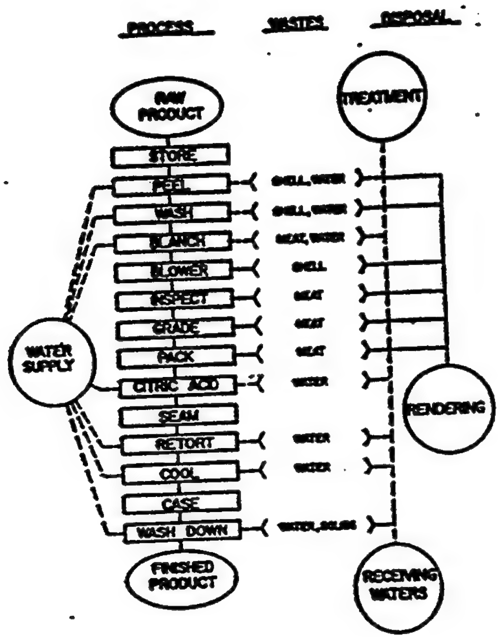
c. Shrimp

Shrimp is Oregon's second largest seafood catch. Pink shrimp is the primary species and makes up around 99% of the Oregon shrimp catch. Several other species including ghost shrimp, brine shrimp and mud shrimp are also landed, but in much smaller quantities (ODF&W 1995). Shrimp is harvested from April through October in Oregon waters, but can be fished in Canada all year and imported for processing (Heater 1994). The shrimp industry in Oregon has remained stable over the past 10 years with slight fluctuations. All of Oregon's shrimp are peeled and cooked before marketing (Radtke 1995). Shrimp are unloaded from the vessel, weighed, and peeled by hand or machine. After peeling, the meat is inspected and washed. After this, the shrimp may be blanched, precooked, canned, cured, and/or breaded. The solid waste which remains after this process is about 70-75% of round catch, made up of shell, viscera, and residual meat. Some other important finished products include frozen and breaded. Shrimp are also marketed as fresh, canned, cured and specialty. Figure 4 shows a typical shrimp operation.

Shrimp processing uses large quantities of water. Rinsing, water flumes, and live steam used in peeling, all contribute to high water demand. It has been found that processing uses 25 - 40 gallons of potable water to produce 1 lb. of finished shrimp (Nielson 1983).

Shrimp waste is high in chitin and ash. These characteristics make it less desirable to fish meal producers (Humphreys 1994). Chitin can be recovered for marketable products, but there are few operations which perform this process.

Figure 4. Flow Diagram for Shrimp Peeling Operation (EPA 1975)

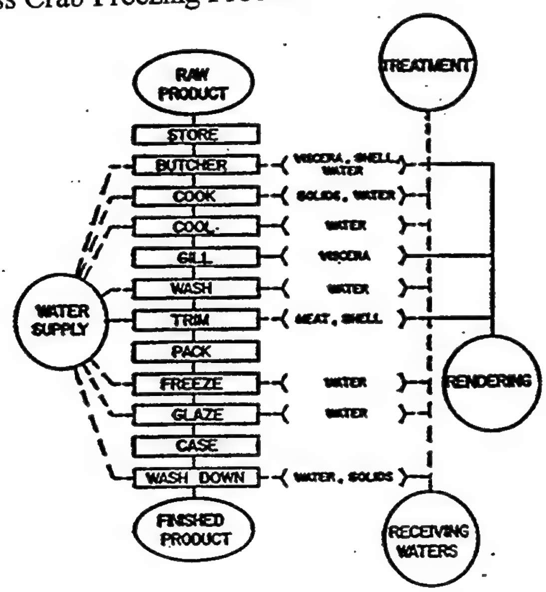


d. Crab

Crab is the third most important catch in Oregon. Commercial fisherman in Oregon harvest primarily Dungeness Crab. Box and Rock Crab are also harvested. The harvest of Oregon Dungeness Crab appears to be relatively stable, with cycling every 10-12 years. Highest catches are brought in during the months of December and January (Bragg 1992). Crabs are usually harvested from baited traps in shallow waters. Crab require special handling to be kept alive as long as possible. Dead crabs decompose rapidly and must be chilled, frozen, or canned immediately. Large quantities of Dungeness Crab are sold cooked in the shell. This practice reduces the quantity of waste to be handled by the processor (Carawan 1979). At most canning plants, whole or butchered crabs are steam-cooked. After cooking, the crabs are cooled and the remaining backs and viscera are removed. The meat is picked from the shell. This product is then

packaged and frozen or canned. (See Figure 5). If the crab is peeled for meat, about 75% of the harvest weight is wasted. This waste is high in protein and chitin. Crab meal or chitin are two options for secondary production, but both have questionable economical health. Some of the larger secondary processors have utilized crab and shrimp wastes in products, but not on a continuous basis. Crab shells can be incorporated into compost operations (Hilderbrand 1995).

Figure 5. Flow Diagram of Dungeness Crab Freezing Process



Source: EPA Report 12060-04/70

e. Tuna

Tuna is the fourth largest catch in Oregon. Prominent species include the albacore, yellowfin, and skipjack (ODF&W 1995). Tuna seems to be becoming more abundant due to ocean conditions, with warmer waters off coast (ODF&W 1995). Tuna is often frozen on board the fishing boats. Tuna is generally thawed, eviscerated, and washed upon reaching the processor The wastes from these operations can be used as byproduct. After butchering, the fish which are to be canned are steam cooked, cooled, and separated from the bone, head, skin, and fins. Dark meat is usually recovered as pet food. The light meat is canned. The recovery of tuna ranges from 35% to 90% depending on the final product (Brown 1995).

f. Salmon

Salmon processing has dropped to number five on the list and currently plays a relatively minor role in Oregon's seafood production, after having been Oregon's trademark fish for over a century. The two most important species of salmon in Oregon are the Chinook and Coho. Chum, sockeye, pink, and steelhead are also included in the catch (ODF&W 1995). Salmon landings have been declining. In 1979 Oregon's commercial landing of salmon was almost 10 million pounds. By 1994 this number had dropped to only 50,000 lbs. (ODF&W 1995a). This decline is believed to be the result of the combination of dams, degradation of spawning grounds, over fishing, and pollution. Several of the Oregon salmon are being considered for the endangered species list (See Figure 7). A major portion of salmon is canned. Canning involves evisceration, beheading, and fin removal. Then, the raw meat is placed in cans, bones included. There is 60% waste for fillet operation to 10% waste for dressed head-on fish (Crapo et al. 1988). See Figure 6 for a flow diagram of a typical salmon/tuna canning operation.

Figure 6. Flow Diagram for a) Salmon and b) Tuna Canning Operation. (EPA 1975)

a) b)

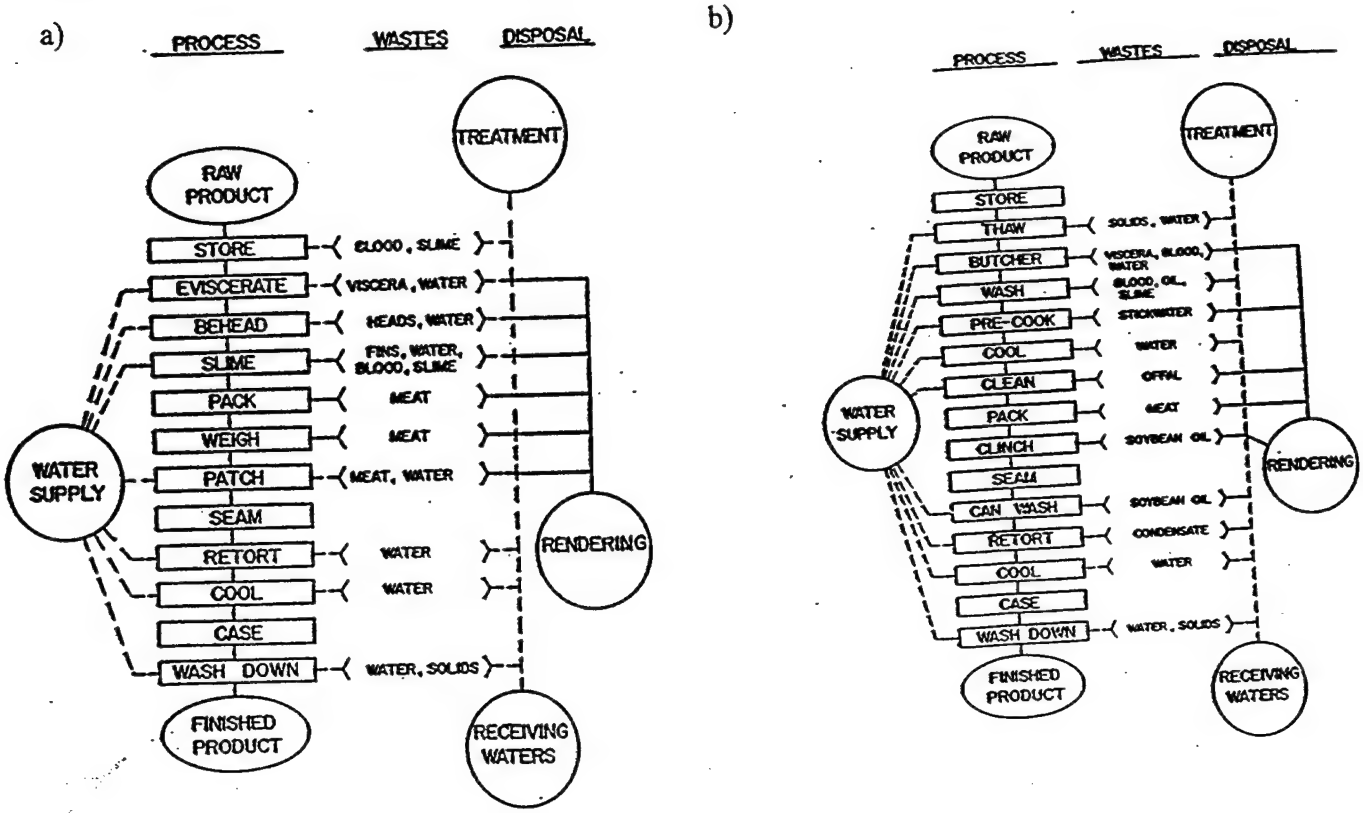
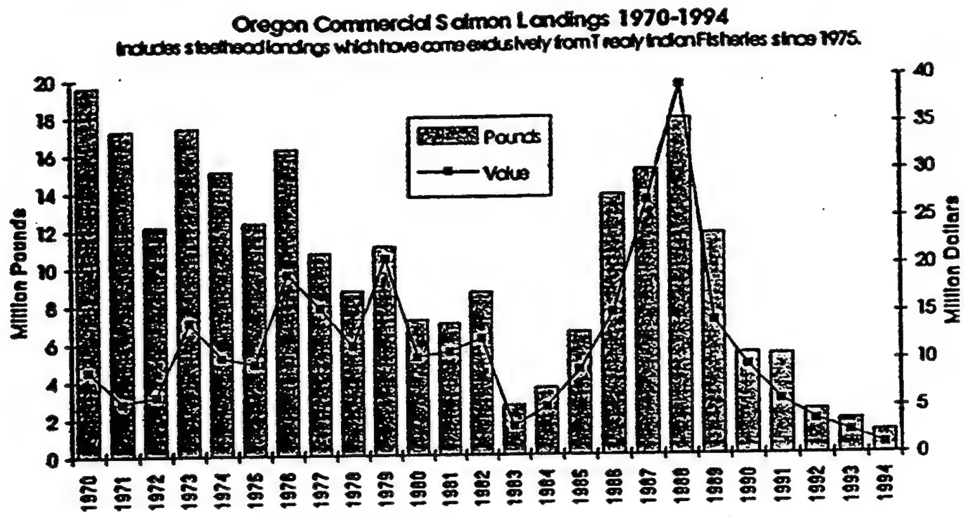


Figure 7. Oregon's Commercial Salmon Catch (1970 -1994) (ODF&W 1995)



Other seafood products in Oregon include clams, smelt, sturgeon, crayfish, herring, mussels, and shark. Scallops and sea urchins have also been contributors to Oregon fisheries and may become more important in years to come.

Table 1. Percentage of catch not used in final product:

	recovery rate	From raw whole to...
Whiting	60	dressed/no head (C)
Bottomfish	65	dressed/no head (C)
	29	fillet (WCFDF)
Shrimp	36	raw peel (C)
	20	cooked peeled (WCFDF)
Crab	24	cooked meat (C)
	89	whole (WCFDF)
Tuna	75	dressed/ no head (WCFDF)
Salmon	73	dressed/ no head (C)
	80	dressed/ no head (WCFDF)

References:
(C) - Carawan 1979.
(WCFDF) - WCFDF 1983.

2. Water use

Water used in seafood processing must be of potable quality in order in maintain health standards. Additionally, potable water must be used to clean all equipment which contacts the food product. State and Federal agencies regulate "potable" water.

Many factors influence the characteristics and volumes of wastewater from seafood processing plants. Some of these factors include:

- variability in raw product (type and age of species, storage time)
- supply of raw product (amount of product being brought in)
- degree of preprocessing
- finished products
- location of plant
- plant age
- operating schedule
- water supply availability and cost
- waste treatment and disposal methods used and associated costs
- time that solid wastes are in contact with water

Table 2. Typical Water Use of Seafood Processor in the United States (Gallon/day)

		Source
Bottom Fish	6,100 - 420,000	Carawan et al., 1979
Dungeness Crab	38,000 - 74,000	Carawan et al. 1979
Fish Meal	38,000 - 93,000	Carawan et al. 1979
Salmon	50,000 - 52,000	Carawan et al. 1979
Shrimp	90,000 - 161,000	Carawan et al. 1979
Surimi	50,000	CH_2M Hill, 1993

3. Typical Waste Stream Characteristics

In general, wastes from the seafood industry contain biodegradable organic matter in the form of dissolved and suspended solids and oils and greases. Some of the most important wastewater parameters include Biochemical Oxygen Demand(BOD), Chemical Oxygen Demand(COD), Total Suspended Solids(TSS), and Oils and Grease(OG).

Biochemical Oxygen Demand - This is a measure of the oxygen required for the oxidation of the organic matter in a sample of water. BOD is an estimation of the amount of organic material present. In seafood processing wastewater, this oxygen demand comes primarily from the organic carbon and nitrogen in solid wastes which have been incorporated in the water through processing. BOD is measured in units of concentration, (mg/L). Common means of reducing BOD include biological treatment such as dissolved air flotation, lagoons, activated sludge, and reduction of organic solids from the waste stream by physical means.

Chemical Oxygen Demand - COD is another measure of the organic content of water. The same wastes which cause the oxygen demand measured by BOD effect the COD. The method for measuring COD can be done much faster (3 hours) than the measurement of BOD(at least 5 days), so COD is often used in situations of continuous monitoring. COD is often a higher number than BOD because there are generally more compounds that can be chemically oxidized than can be biologically degraded. This measurement can not always be used as a reliable predictor of BOD due to difficulties in comparing sensitivity to loading. COD is also measured in units of concentration (mg/L).

Total Suspended Solids - is a measurement of the amount of suspended solids in a waste stream. Suspended solids can cause several problems. First, if the solids are settable, they will likely collect on the floor of the receiving water body and can effect the bottom-dwelling flora and food chain. Second, if the particles remain in solution or float they reduce the amount of light which enters the water, possibly effecting wildlife. Settable solids can be measured with an Imhoff cone. In this procedure material is settled out in a cone and recorded after fixed times. Suspended solids can be measured by passing water through a filter. The trapped solids are dried

and weighed. TSS can be reduced by physical means such as settling, screening, and dry cleanups. Additionally, dissolved air flotation (DAF), coagulation, and other methods effectively remove suspended solids.

Oil and Grease - Oils and grease are a common characteristic of seafood processing wastewater. Amounts are variable depending on the type of processing and the species being processed. For example, canning generally yields higher oil and grease than filleting operations. Tuna processing is usually higher in oils and grease than clam processing. Oils and grease usually float to the surface of waters creating a film. This layer not only decreases the oxygen transfer and evaporation between the air to water, but is not aesthetically pleasing. Additionally, oils and grease can also attach to pipes and ducts reducing flow and increasing head loss within a plant. This parameter is usually measured by solvent extraction. Oils and grease are measured in units of concentration, (mg/L). Common methods for reduction of this parameter are dissolved air flotation (DAF) and coagulation.

Flow - the amount of water used in processing fish is also of concern. This parameter is directly related to how much wastewater will be produced and its concentration.

Minimizing pollutant concentrations and water usage values will decrease municipal wastewater treatment costs and /or decrease the cost of operating a pretreatment or treatment system. These parameters can be defined by monitoring the plants processing flow. Depending on these wastewater characteristics, a number of different plans and options can be implemented to meet discharge requirements. Seafood wastewater is generally regulated by BOD, TSS, and Oils and Grease parameters. Some typical values for seafood processing waste water are listed in Table 3.

Table 3. Typical Seafood Processing Wastewater characteristics (mg/L) as reported in the literature.

	BOD	TSS	Oil/G	Source
Bottom fish	200-1000	100-800	40-300	Carawan, 1979
Dungeness Crab	280-1200	60-130	28-600	Carawan, 1979
Salmon	253-600	120-1400	20-5500	Carawan, 1979
Shrimp	2000	900	700	Carawan, 1979
Surimi	15000	8000	-	CH_2MHill, 1993
	3700	2283	121	AAFC Canada, 1992
(pH - 6.6)	3308	1767	59.8	Pt Adams 1995-97
Tuna	700	500	250	Carawan, 1979
Fish meal	91-380	76-266	19-76	Carawan, 1979
Fish pumping	2100-7400	10-1504		Gonzalez, 1991
Bloodwater (fishmeal)	23500 -34000	0-1.92%		Parin, 1979
Stickwater (fishmeal)	13000 -76000	60-1560		Gonzalez, 1991

Some other parameters to consider:

Dissolved Oxygen - This is a measure of the amount of oxygen present in water. This is of primary concern in the receiving water, where organisms especially fish, require a certain level of dissolved oxygen to survive.

Temperature - The temperature of the waste stream must not be such that it increases the temperature of the receiving water. Increases of greater than 2 to 3 degrees C can effect local populations and oxygen levels. Seafood processing which involves sterilization or canning may be of concern. Wastewater from these operations should be cooled if the receiving body is not large enough to absorb this with less than a 3 degree fluctuation (Gonzalez 1996).

Turbidity – This is a measure of the suspended particles which cause water to look cloudy. If the water is too cloudy the particles will block out light needed by plants and animals for energy.

pH – This is a measurement of the intensity of acidity or alkalinity of the water. It is an important parameter for wastewater since it may help identify contamination or the need to

correct for certain treatments. Many organisms are very sensitive to pH changes. Their behavior and survival may be affected by changes in the pH of the receiving waters.

Bacteria/Fungi - This parameter looks at the presence of harmful bacteria or fungi which may infect local flora and fauna. This is also a concern for human health that may be affected by contaminated water or seafood product. Disinfection techniques such as chlorination can be used if this is a concern.

Nitrogen and Phosphorous - These elements are of environmental concern because they are important nutrients for living organisms. If present in excess, they can cause proliferation of algae(algae blooms) which use up significant amounts of oxygen normally used by other organisms. Nitrogen and phosphorous are both present in seafood waste water.

Some other parameters that may be important in evaluating effluent discharge into local waterways are problems with taste and odor, bottom and sludge deposits, discoloration and sludge, and oily slick.

Most seafood waste water can be divided into two main flow characteristics:

1) High volume, low strength wastes – from water used in unloading, fluming, transporting, handling, and clean-up.
2) High strength wastes – stickwater from evisceration, precooking, and cooking operations.

Frequently, these two waste water streams can be separated during processing, thereby being treated more appropriately.

The control of water and wastes in the seafood processing industry is only possible by attacking the water use and wastes at the various sources - each plant is different and must be looked at separately (Carawan 1979).

III. REGULATION

1. Background on Seafood Processing Wastewater Regulations:

The Federal Water Pollutant Control Act Amendments of 1972 were designed to regulate the discharge of pollutants into the navigable waters of the United States. Four national policies were adopted: 1) No one has the right to pollute the navigable waters through unauthorized discharge; 2)Permits shall limit the compositions of a discharge and the concentrations of the pollutants in it; 3) Some permit conditions require the best available technology, regardless of the receiving water's conditions and natural cleanup; and 4)limits which are established higher than the federal standards must be based on quality of receiving waters (Clean Water Act). This act is administered by the US Environmental Protection Agency(EPA) which issues permits for discharge into these waters. The 1972 Amendments also established the National Pollutant Discharge Elimination System(NPDES). The main goals of this permitting program were to eliminate the discharge of pollutants into navigable waters by 1985 and to achieve water quality levels that would protect flora and fauna, and provide for recreation wherever possible. The NPDES permit program sets limitations on effluent and defines monitoring and reporting requirements.

The US Environmental Protection Agency Seafood discharge guidelines of 1972 were established after extensive study of many factors including nature of wastes, manufacturing processes, availability and cost of pollution control systems, age and size of plants in industry, and environmental implications of controlling water pollution. These guidelines are the minimum standards for the NPDES permits nation wide.

In most cases, the responsibility of permitting has been delegated to the state with guidelines established by the EPA. In Oregon, the Department of Environmental Quality issues general as well as individual NPDES permits.

The state agencies are authorized to issue a general permit to point sources which:

- Involve similar types of operations
- Discharge the same types of wastes
- Are located within a geographic area
- Require the same effluent limitations
- Require the same operating conditions
- Require similar monitoring requirements
- In the opinion of the EPA, some operations are more appropriately controlled under a general permit than under individual permits (Clean Water Act)

By July 1, 1977 the law required existing industries to reduce their pollutant discharges to a level attainable by using the "best practicable" water pollution control technology (BPT). This standard was determined by averaging the pollution control effectiveness achieved by the best plants in the industry.

On July 1, 1983, the law required existing seafood industries to reduce their pollutant discharges even more. This new standard was defined by the "best available" pollution control technology(BAT). BAT is based on using the best technology economically feasible for pollution control.

The law required new seafood plants to limit pollutant discharges in order to meet national "standards of performance" established by the EPA. They must meet these stricter standards before they begin production.

a. EPA Guidelines

The Federal Water Pollution Control Act of 1987 resulted in even more strict EPA guidelines for seafood processing wastewater. This change caused a large push in the industry to pursue alternatives waste disposal methods. Regulation, in addition, to an increased world market for fish protein, created a situation for implementing these technologies economically.

The laws prepared by the US Environmental Protection Agency do not state which technologies must be used. They only require that the industries limit their pollution discharges to prescribed levels. The most recent regulations: 1) Set limits on identified pollutants that can be discharged by plants. These limits are defined for sub-categories of seafood. 2) Established maximum limitations for BOD and suspended solids that can be discharged in one day and average over 30 day period. 3) Established guidelines for BPT and BAT. 4) Established pH ranges for the effluent at 6-9, and 5) Established performance standards for new plants. The levels defined by the EPA for new plants are shown in Table 4. These guidelines also state that if these national discharge standards are not strict enough to achieve water quality, tougher controls can be adopted. The national discharge requirements are minimum standards that all industries must meet.

Table 4. Minimum Wastewater Discharge Guidelines defined by the EPA, New Source Performance Standards (mg/L).

Species	BOD_5		TSS		Oil & Grease	
	Monthly Avg	Daily Max	Monthly Avg	Daily Max	Monthly Avg	Daily Max
Crab	4.1	10.0	0.69	1.70	0.10	0.25
Shrimp	62.0	155.0	15.0	38.0	5.7	14.0
Salmon (Hand)	1.4	1.7	0.37	0.46	.023	.058
Salmon (Mech)	32	36	6.5	7.9	1.5	3.8
Bottom Fish (Mech)	7.4	9.1	2.5	3.3	0.39	.68
Bottom Fish (Conv)	0.58	0.58	0.73	1.5	.03	.04
Clam (Hand)	--	--	17.0	55.0	0.21	0.56
Clam (Mechanized)	5.7	15.0	4.4	26.0	.092	0.4
Oyster (Hand)	--	--	35.0	37.0	1.6	1.7
Scallop	--	--	1.4	5.7	0.23	7.3
Fish Meal	2.9	4.0	1.3	2.3	0.63	0.8
Tuna	8.1	20.0	3.0	7.5	0.76	1.9
Surimi	--	--	--	--	--	--
Other	--	--	--	--	--	--

pH range: 6 - 9

	Technology basis
Crab	S, DAF, IP
Shrimp	S, DAF, IP
Salmon (Hand)	IP,S,B
Salmon (Mech)	IP, S, B
Bottom fish (Mech)	IP, DAF, S
Bottom fish (conv)	IP, S, AL
Clams (Hand)	IP, S
Clams (Mech)	IP, S, AL
Oysters (Hand)	H, S
Scallops	IP, S, B
Tuna	S, DAF, IP

S = screen
DAF = Dissolved Air Floatation w/o chemicals
B = Barge solids
IP = in process plant changes
H = house keeping
AL = aerated lagoon

Most of the seafood processors in Oregon dispose of their wastewater through pipes which feed directly into rivers or estuaries. These processors are regulated by the Clean Water Act which falls under the state's 900J permit. A NPDES Permit is essentially a contract between the agency and the processor with penalties for non-compliance.

The Marine Protection Research and Sanctuaries Act (MPRSA) regulates the ocean dumping of all types of materials and gives permitting authority to the EPA and the Army Corps of Engineers. Processors will be regulated by the MPRSA if the waste is dumped outside of one mile from the coast. If the dumping is done within one mile it may fall under the jurisdiction of the state fish and wildlife agency, because of the potential impact on the marine nutrition cycle of the area.

b. Oregon Department of Environmental Quality

Oregon State General Permit 900J - This permit, established by the Clean Water Act in 1975, allows land based seafood processors to screen their waste and discharge into adjacent waterways so long as the effluent quality is within established waste water parameters. Water quality guidelines are established but are not regularly monitored. This permit has different standards for start up dates before and after July 30, 1975, similar to the EPA guidelines for Best Available Technology and New Sources. These specific guidelines for TSS, Oil and Grease, pH and BOD are outlined in Table 5 for all new sources. The water quality standards defined in this permit are at least as stringent as those established by the EPA Best Processing Technology Site Guidelines. The permit requires that processing waste waters shall pass through a screen at least

as fine as 40 mesh (or equivalent control) before discharge. It also outlines the minimum monitoring and reporting requirements and procedures. These are presented in Table 7. The permit also states the penalties for non- compliance. The purpose of this permit is to monitor seafood waste water and control water quality. The 900J permit expired 1 January 1997, but remains as the standard until the permit is revoked, reinstated, or revised. The Oregon Department of Environmental Quality is working on revising and reissuing the 900J permit by the end of 1997. This process involves determining what needs to be changed or kept the same to ensure that the permit effectively controls water quality without unnecessarily constraining the industry. See Appendix C for a copy of the 900J Permit.

Table 5. Minimum Waste Water Discharge Requirements defined by the General Permit 900-J for Seafood Processors in Oregon. (mg/L)

Species	BOD_5 Monthly Avg	Daily Max	TSS Monthly Avg	Daily Max	Oil & Grease Monthly Avg	Daily Max
Crab	4.1	10.0	0.69	1.70	0.10	0.25
Shrimp	62.0	155.0	15.0	38.0	5.7	14.0
Salmon (Hand)	1.7	2.7	0.42	0.70	.026	.045
Salmon (Mech)	38.0	62.0	7.6	13.0	1.5	4.2
Bottom Fish (Mech)	7.5	13.0	2.9	5.3	0.47	1.2
Bottom Fish (Conv)	0.71	1.2	0.73	1.5	.042	.077
Clam (Hand)	--	--	17.0	55.0	0.21	0.56
Clam (Mechanized)	5.7	15.0	4.4	26.0	.092	0.4
Oyster (Hand)	--	--	36.0	45.0	1.7	2.2
Scallop	--	--	1.4	5.7	0.23	7.3
Fish Meal	3.8	6.7	1.5	3.7	0.76	1.4
Tuna	8.1	20.0	3.0	7.5	0.76	1.9
Surimi	--	--	--	--	--	--
Other	--	--	--	--	--	--

Guideline for all new sources (Those started after July 30, 1975)
(ODEQ 1992)

Some of the larger seafood processing operations have been issued individual permits which are more specific to their size and waste stream characteristics. Due to their large output these larger

plants require more complex treatment and monitoring than the general permit can provide. (See Figure 6 and Appendix D)

Figure 6. Discharge Requirements for a Surimi Processing Plant regulated by an Individual Permit

There are no federal effluent guidelines for surimi or other possible processing activities. Individual permits have been issued to large surimi processors in Oregon. (ODEQ Permit number 900-J, 1992)
Typical effluent requirements for surimi wastewater after DAF:

Parameter	Monthly Average	Daily Maximum
BOD5	7,000 lbs/day	14,000 lbs/day
TSS	700 lbs/day	1,400 lbs/day
Oil and Grease	300 lbs/day	600 lbs/day
pH	shall not be outside the range of 6 - 9	

(ODEQ Permit Number 101214, July 13, 1994) See Appendix D

Table 7. Minimum Monitoring and Reporting Requirements - General Permit - 900J

Parameter	Frequency
All categories processed:	
Raw Product - (lbs of each species)	Daily average for the month
Waste Solids Generated	Total per month
Waste Solids Disposed	Amount and location
Inspection of Screens	Daily
Screening Failures	As they occur
Total Suspended Solids (TSS mg/L)	Monthly Composite*
Oil and Grease mg/L	Monthly grab*
Wastewater Flow (million gallon/day)	Average daily
Fish Meal or Tuna:	
Biochemical Oxygen Demand (BOD5)	Monthly composite**
Total Suspended Solids (TSS)	Monthly composite**
Oil & Grease	Monthly grab**
Surimi (Dehydration wastewater and final effluent):	
Biochemical Oxygen Demand (BOD5)	Weekly composite**
Total Suspended Solids(TSS)	Weekly composite**
Oil & Grease	Weekly composite**

Monitoring results shall be reported on approved forms. The reporting period is the calendar month.

* Where all wastewater is screened through fine screens (40 mesh or finer), the analysis for TSS, and Oil and Grease is not required for products other than fish meal, tuna, and surimi. Where alternative methods are employed, the Department may waive the requirement for TSS and Oil and grease.

** After two years of monitoring at the above frequency, the Department may reduce the frequency of monitoring for fish meal and tuna, provided that compliance has been demonstrated with the treatment technology employed. After effluent limitations have been established and compliance demonstrated, the department may reduce the frequency of monitoring for surimi. Source: DEQ, 1992.

See Appendix F for example of the monitoring data reported to the DEQ.

Dr. Mike Morrissey, Oregon State University, feels that permits should be issued for different areas of out fall or ports rather than having one general permit. This way each estuary or seafood processing centers can be looked at individually for specific out fall areas and mixing characteristics. Areas such as Astoria on the Columbia River may need no change in effluent characteristics because the area of out fall is large and has good mixing (1997).

The Department of Environmental Quality has established water quality standards for surface waters in the state. There are separate standards for fresh, estuarine and marine waters for levels of temperature, oxygen, turbidity, acidity, and bacteria specified in OAR 340-41-242 through OAR 340-41-245-(2) (e). These effluent discharge requirements are outlined in Table 8. These conditions may be suspended by DEQ in "mixing zone" by both general and individual wastewater permits like the 900J permit, OAR 340-41-245 (c). Mixing zone standards include:

- must be small as feasible
- should not overlap with other mixing zones
- should cause minimal adverse effects on local aquatic life
- should not threaten public health
- should minimize the effects on uses outside the mixing zone

Table 8. Specific DEQ Standards for Effluent Discharges

	Fresh	Estuarine	Marine
Dissolved Oxygen	Concentrations greater than 90% of saturation at the seasonal low or 95% of the saturation in spawning areas during activities	Not less than 6 mg/L (except in upwelling areas)	Not less than saturation concentration (except in upwelling areas)
Temperature	No measurable increase outside mixing zone. For specific numbers see OAR 340-41-245 (2) (b) (A)	No significant increase above natural background temperatures shall be allowed and no alteration which might adversely effect aquatic life	Same as Estuarine
Turbidity	No more than 10% increase unless DEQ and ODF&W allow. Dredging and construction require permits.	Same as Fresh	Same as Fresh
PH	6.5-8.5	6.5-8.5	7.0-8.5
Bacteria □ Fecal coliform	Log mean of 200/100 mL based on minimum of 5 samples in a 30-day period with not more than 10% of the samples exceeding 400/100mL	Log mean of 200/100 mL based on minimum of 5 samples in a 30-day period with no more than 10% of samples exceeding 400/100 mL (Does not include shellfish growing waters)	Median of 14/100 mL not more than 10% of samples exceeding 43/100 mL (Includes estuarine shellfish growing waters)

Source: DEQ 1994

Obtaining a permit for waste water discharge requires the following information plus a fee: type of operation, characteristics of effluent flow and composition, characteristics of low flows of receiving waters, environmental effects and proposed design. Subsection 2 of OAR 340-41-255 covers minimum design criteria for treatment and control of industrial wastes including seafood processing wastes. The policy outlined in ORS468B.015 lists five goals:

- Conserve state waters
- Protect, maintain and improve water quality for a variety of uses including both aquatic life and industrial
- Ensure treatment of wastes before entering state waters
- Prevent or control water pollution
- Cooperate on a state, interstate, and federal level

Several plants on the coast discharge their wastes into their local publicly owned treatment facilities. These plants are not covered under the 900J permit. Processors which dump their wastes into municipal sewers face strict discharge requirements and sewer charges. Waste waters sent to treatment plants must not damage the effectiveness of the plant and must be of such quality to be adequately treated by the waste water treatment plant. In some cases, pretreatment of seafood processing waste water may be required. It is of greater financial impact for these operators to focus on reducing water use in their processes since they are paying for the water coming in and out of the plant.

c. The Fisheries Enhancement Permit

The Department of Fisheries and Wildlife issues a permit which allows seafood processors to dump solid wastes from their processes to receiving waters. The permit was designed to use the seafood processing waste as an enhancement to local floral and fauna. It is an inexpensive way to dispose of seafood processing wastes where other discharge options are not available. The permit places stipulations on the amount of wastes that can be discharged, the maximum size

of particles to be discharged, and the times when these wastes can be discharged during ebb tides. The permits are issued for an unlimited period of time. They require monitoring of the amount of discharge and the times. Additionally, any physical changes to the estuary and its biological community should be reported to the ODF&W. John Johnson, of the Oregon Department of Fisheries and Wildlife, who overseas the program, stated there is no evidence the Fisheries Enhancement program is causing any problems to the environment. He also noted that there has been an increase in the sturgeon population in the lower Columbia around areas where plants are operating under the fisheries enhancement permit. There is no evidence that the permit discharges are related to this increase in population (1997). In 1982, a study was begun to look at the effects of the Fisheries Enhancement Permit on the Umpqua River Estuary. The project was discontinued after the two plants which were discharging solids under this permit stopped processing. Preliminary findings were: 1) if the effluent is discharged during ebb tides; 2) river flow conditions to ensure adequate flushing from out fall areas, the seafood waste does not create an environmental problem. In another case, "a zone of undesirable effects beyond the out fall could be a serious problem in a narrow confined estuary, where juvenile and larval fish or anadromous species require passage" (Miller 1984). Further research is needed to evaluate the biological effects of this type of dumping into specific estuaries. Each estuary system has different physical processes and biological communities. There is a need for a study (studies) to determine procedures and amounts of seafood wastes that can be discharged into various estuaries without creating objectionable problems.

According to Tim McFetridge, of the Department of Environmental Quality (Central Region, Salem Office) who was involved in writing the Fisheries Enhancement Permit, the Fisheries Enhancement Permit is a transition solution to the seafood waste problem. More secondary waste processors are being established to utilize these wastes. It may not be economically feasible to dump solid waste when it could be sold to secondary producers. The Fisheries Enhancement Permit may not be used in the future (1997).

See Appendix D for a copy of the Fisheries Enhancement Permit.

2. Evaluation of the current permit

Tim McFetridge, expressed his concern that the 900J permit is not meeting its goal of monitoring and reporting (1997). According to Rajeev Kapur, of the Oregon Department of Environmental Quality Central Office, the permit is outdated and does not require sufficient monitoring or handling technology (1997). He sees a need to have comprehensive studies done to evaluate what impact seafood processing waste discharges are having on the receiving waters and associated habitats. These studies have not been done on a consistent basis, and it is unclear what the effectiveness of the current 900J permit is.

Documented examples of water quality problems caused by seafood processing:

Kodiak is Alaska's largest seafood processing area with 15 plants along 2.5 mile ocean front. Prior to 1971, when the processors were required to initiate screening of plant effluents, unfavorable water conditions were reported. The discharge of untreated waste streams formed localized accumulation of decaying organic matter which produced gasses and floating scum. By 1974, dissolved oxygen concentrations had improved, decaying fish waste, hydrogen sulfide bubbles, and floating scum were not noticeable, indicating that water quality was improving. However, a sludge layer and a limited benthic community showed that further improvements was needed (Tilsworth 1984).

Dutch Harbor is Alaska's second largest area. An investigation on the receiving waters of Dutch Harbor was conducted in 1976-77. In 1976 - 72 million lbs. of seafood was processed, with an estimated two thirds discharged. Dissolved Oxygen levels below 6 mg/L, were found at depths below 25 meters and near the bottom. Elevated concentrations of ammonia and phosphorus were also measured. Bottom sediment sampling showed high levels of organic matter and sludge deposits exceeding three inches. Dive studies showed extensive shell piles and new waste deposits. Concentrations of hydrogen sulfide ranged from 0.1 to 5.9 mg/L in the water (Tilsworth 1984).

Yaquina Bay, Newport, OR 1992: According to a 1992 study there was industry wide violation of the 900J permit as well as extensive environmental impacts, and destruction of the

aquatic habitat. Some examples of this include: bay bottom under the plants were "littered with large old decaying bottom fish carcasses"; "odors were bad"; and "the edge of the bay water was septic and a distinct band of blackish gray water was easily visible extending out approximately 20 feet into the bay." "The normal aquatic ecosystem is gone, and the only life forms we observed were small brown sea anemone, mostly restricted to elevated heights on dock pilings" It was suggested that the 900J permit may not be suitable for those facilities producing shrimp and surimi and operating in bay areas with restricted flushing (Messer 1992).

Charleston, OR – In 1995 there were complaints of seafood waste discharges showing up on public beaches. A study discovered a broken outflow pipe for one of the plants. A study was done by the ODEQ. The plant redirected its out fall to combine with a local fish meal plants out fall pipe. This solution seemed to fix the problem. One year of monitoring indicated that organic wastes were absorbed into the system (ODEQ 1995).

Another incident of shrimp wastes washing up on the beach was eliminated by relocating the out fall pipe of one seafood processor in Southern Oregon (Kretzchmar 1997).

An evaluation of offshore dumping of crab processing waste in Tangier Sound, Maryland (Krantz 1983) have shown a reduction of water quality which included low dissolved oxygen, the accumulation of wastes, and high coliform bacteria counts at the dump site.

Studies of tuna waste in Los Angeles Harbor showed a zone within 200 feet of out fall where biological productivity was depressed (Emerson 1976).

3. Anticipated Changes in the Regulatory Climate:

Oregon's neighboring states, California and Washington, have more restrictive monitoring requirements for seafood processing waste streams. Alaska's discharge requirements are similar to Oregon's due to their larger size and isolation, but their monitoring program is more extensive than that of Oregon. These states regulations may point the direction that Oregon will follow.

California is split into nine different regions each of which has their own regional water quality control offices which are responsible for water quality. In Northern California, Region 1,

no general permit is available for estuarine discharge. Seafood processors must discharge into municipal waste water treatment facilities or obtain individual NPDES permits at a cost (Brown 1995).

Washington does not issue general permits either, but has regional areas of jurisdiction which regulate water quality. They have established permit fees specific to each industry which are further defined based on amount of effluent produced (Brown 1995).

Alaska seafood processors are authorized to discharge into waters by a general NPDES permit (No AK-G52-0000). It is based on "best available technology" which allows seafood processors to discharge solids after grinding to half inch particle size. The sea floor and receiving waters must be monitored. Environmentally sensitive areas are excluded by the general permit. These areas include such areas as rookeries, sanctuaries, degraded waters, and designed fish processing centers. Each of these areas has a total maximum daily load defined by the EPA. Waivers can be obtained for these exclusions from the EPA and Alaska Department of Environmental Conservation.

Alaska's plan for monitoring wastes as of Nov 1, 1994 includes:

1) annual production and discharge data

2) seafloor deposition for discharges within 1 mile of shore and less than 30 fathoms deep. Small operations every 5 years, larger more frequent.

3)sea surface and shoreline deposition on daily basis for shore operations(0-1/2 mile out) and weekly for near shore operations (1 to 1/2 mile out).

(EPA Seafood Permitting Update, Jul 1994, US EPA Region 10)

The regulatory climate in Oregon will likely become more strict with respect to seafood processing wastewater discharges in the near future. This comes with an increased sensitivity to environmental conservation in the United States and around the world. Oregon's waters are being more thoroughly monitored, especially our estuaries. Sustaining our environment, wildlife and natural resources for future generations is a popular cause that we are tackling as a society.

IV. WASTE WATER

Seafood processing solid waste disposal and waste water treatment are often considered as two different problems. The two are actually closely interrelated from the wastewater standpoint. When solids are removed from the wastewater stream for by product recovery or disposal, the wastewater is being cleaned. Capturing these wastes before they are wasted to the sewer or onsite treatment operation helps solve two problems. First, waste can be utilized to produce other important products. Second, solid wastes contribute to the strength of the wastewater and add to the waste treatment cost. The economics of waste water depends upon the amount of product lost and the cost of treating the waste water. The cost of lost product is relatively simple, but the wastewater costs are dependent on its characteristics. Two primary characteristics are the amount and strength of the wastewater. Other characteristics become more important and when specific discharge requirements are identified. The environmental ramifications of not adequately removing pollutants from the waste stream can have serious ecological effects.

Becoming familiar with the techniques available for waste water treatment is important for the future of those involved in seafood processing. Wastewater treatment in seafood processing is very similar to other food processing operations. It is beneficial to look at how other food processors have dealt with the problems associated with waste disposal and water use for ideas that apply to seafood processing. Seafood processing share some of the same obstacles as the food processors including seasonal and variability in type and amount of raw product, high organic contents in waste and wastewater, and odor problems.

This section provides an overview of the wastewater treatment technologies and options which have been applied to the treatment of seafood processing wastewater. Some of the technologies presented will not be financially and technically feasible for all seafood processors in Oregon. Nor will there be the need to implement wastewater control to the extent provided by some of the options. There is no clear indication that water quality to the receiving water body will be improved by the implementation of these technologies. The options presented will help to

improve the quality of wastewater exiting a plant. The specific waste stream characteristics, final effluent discharge requirements, and the economic feasibility should drive the selection of waste water treatment options.

1. Obstacles:

The typical remote location of most seafood processors, contribute to the high cost for energy, material, and transportation involved in the treatment of seafood processing wastewater. Many plants are located on docks or near the water. The lack of land or floor space at most plants makes it difficult to expand and add waste treatment facilities. Another obstacle of importance is obtaining a representative sample of the effluent (Carawan 1979). Representative samples are important in waste water treatment design and daily management as well as for reporting.

Some things to consider in taking samples:

- Once obtained, analysis should be initiated as soon as possible
- Ensuring the sample is taken from a representative waste stream – taken from a flow that is well mixed. Composite samples may be used
- Use prescribesd sampling techniques
- Protect the samples from contamination until they are analyzed

Despite the variability in wastewater coming from different seafood processing operations there are some common techniques that will help to improve wastewater quality of the effluent at all plants.

1) minimize the amount of water used (reduce the loss of solids)

2) recover the suspended and dissolved solid from the waste streams

3) recover solids from processing

It is also important that solid removal from the water stream happen as soon as possible. The longer solid seafood wastes are in contact with water the higher the BOD and COD of the wastewater. Additionally, the by-product recovery decreases.

Before designing a seafood processing plant or a wastewater treatment option for an existing plant, an in-plant waste control program should be initiated. This not only reduces the loading on plant waste water, but also recovers valuable products which can be used for human or animal consumption or use.

Wastewater characteristics and the amount of flow are the two main parameters in the design of waste water treatment systems. Generally, seafood processing wastewater contains considerable amounts of insoluble suspended matter which can be removed by different physical and chemical means. Important waste water characteristics for seafood processing wastewater include Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), Oils and Grease (OG), and pH. These characteristics are also discussed starting on page 16.

2. Discharge Options:

There are several options being used for wastewater disposal. These include discharge into adjacent water ways, sewer system, ocean dumping, and land application.

Discharge direct into the surrounding water -

With a NPDES permit seafood plants can discharge wastewater directly into streams, bays, sounds, rivers, creeks, and or estuaries. Permits are usually obtained from the state environmental control agency, in Oregon that is the Department of Environmental Quality. Permit requirements are governed by the NPDES which define the maximum amount of pollutant that anyone may discharge into a body of water. Oregon currently requires a minimum of a 40 mesh screens before discharge into receiving waters.

The issue of outfall water quality may need to be approached from a more holistic view. It is not only seafood waste water which is being dumped into these estuaries, but sewage, pulp effluents, food wastes, and other organic materials. It is difficult to say if the system can continue to accept all of these additions and maintain water quality, species habitat, and natural beauty.

While seafood waste may not seem to effect water quality by itself, it is only a piece of a much larger anthropogenic waste stream.

Municipal sewers –

Many small industries discharge wastewater to the public sewer system where processors are located away from the water, where intensive treatment would be required, or other unique situations occur. The cost of sending large amounts of industrial wastewater to a public facility is often high. Pretreatment of waste may be required prior to sending waste water into the municipal systems. The degree of pretreatment will generally be determined city ordinances. In Oregon, these limitations vary from city to city. Another consideration is whether or not the local treatment facilities has capacity to handle the quantity and concentrations of the waste stream. Many seafood processors are located in or near small communities whose plants may not have sufficient reserve capacity to handle these loads.

Forms of pretreatment are usually the same technologies as used in wastewater treatment to meet permit limitations in the same or possibly a scaled down version. Some pretreatment examples include screening, coagulation, DAF, and cyclones. These are all described later in the waste water treatment technology section.

Municipal sewage charges for industrial plants are often based on volume discharged and a strength factors. Sewer use ordinances may be revised in order to meet costs. Understanding the sewer ordinances and keeping updated on any changes is important in deciding to use this option. Additionally, the economics of using municipal wastewater treatment facilities as compared to in-plant wastewater treatment options are important things to look at.

Ocean Disposal-

Ocean dumping (barging) of waste water is an option for plants without access to municipal wastewater treatment facilities or the possibility of discharge into adjacent waterways. Barging requires high capital investment and high operating cost. Additionally, the permitting of this type of dumping is complex and difficult to obtain. The argument for this option is that it

returns nutrients to the sea. There have been no documented cases where ocean dumping of seafood waste have caused any noticeable effects on the environment.

Land Application / Wetlands –

The discharge of seafood processing wastewater to land or wetlands is another option for disposal. These options are only attractive if the problems of limited land availability and/or transportation costs can be overcome. It has been shown that limited application of wastewater to wetlands or constructed wetlands can be done without detrimental effects on the environment (Turner 1976). In some areas this may be a viable alternative to wastewater disposal, but more research is needed in order to design land treatment systems effectively for seafood wastewater. High concentrations of nitrogen, phosphorous, oil and grease, trace anions, and metals characteristic of seafood processing wastewater have unique effects on the systems, and can improve soil quality in most cases (Overcash 1980). The application of seafood processing waste water on agricultural lands using irrigation equipment is another application which may prove to be important in the future.

The remainder of this section is divided into two main parts. First, alternative in-plant control techniques will be described and compared. The second section gives some techniques for in-plant reduction of water use.

3. Alternative Wastewater Technologies Available: Effectiveness and Economics

For optimal treatment of seafood processing waste water, some form of primary treatment is recommended before secondary biological, chemical, or other application. Primary treatments are classified as physical processes designed to remove floatable and settable solid material from the wastewater. In seafood wastewater these solids may include fish scales, portions of meat, bone, or shells. Secondary treatments generally involve biological processes which are designed to remove the dissolved organic load from the waste stream. Tertiary treatments are used to further treat sludge from the primary and secondary treatments, or further treat secondary waste water with stabilization/polishing ponds. Tertiary treatment is not generally practiced on the

Oregon coast. This is due to the lack of need to use these processes to achieve current and past water quality standards for seafood wastewater. The degree of treatment will largely depend on the requirements for disposal of water.

An overview of treatment alternatives is presented in Table 9. This table shows available options for waste water treatment and waste reduction, variables affecting each, and which applications they are best suited for.

Table 9. Seafood Industry Wastewater Treatment Practices/Technologies typical effluent reductions

Treatment System	Use	Effluent Reduction	Source
Screens	Primary Treatment	TSS, 40-75%	Gonzalez,1996
Sedimentation	Primary Treatment	--	
DAF	Primary Treatment	Grease,60% BOD5, 30% TSS 30% TSS 80-95%	Carawan, 1979 EPA, 1975
DAF with pH control and flocculant	Primary or Byproduct	Grease, 90-95% BOD_5, 50-75% TSS, 60-97%	Carawan, 1979 EPA, 1975 Carawan, 1979
Cyclones	Primary	TSS, 80 - 90%	Tilsworth, 1980
Aeration/Lagoons	Secondary, biological	BOD_5, 90-95% TSS, 95-99%	Carawan, 1979 EPA, 1975
Activated Sludge	Secondary, biological	BOD_5, 90-95%	Carawan, 1979
Trickling Filter	Secondary, biological	BOD_5, 70-90%	Gonzalez, 1996
RBC	Secondary, biological	BOD_5, 75-95%	Metcalf/Eddy 1979
Land Applications	No discharge	Total	Overcash 1980

a. Primary Treatments:

Primary treatment is designed to remove floating and settling solids. These processes generally rely on physical operations and are designed based on particle size density. Some common treatments include screens, flow equalization, sedimentation, dissolved air flotation, and cyclones. Primary Treatments can generally remove up to 85% of TSS, and 65% of BOD present in waste stream. (Carawan 1979).

i. Screens -

Screens serve as a barrier for suspended materials to be removed from the waste water stream. This method works well for removing large solids (.7 mm and larger) quickly and simply. They can be applied in many different areas in seafood processing plants. The EPA and most states recommend at least a 20 mesh screen as a minimum treatment for seafood waste streams. In Oregon, the General Discharge Permit # 900J Oregon requires 40 mesh screens as pretreatment of waste waters discharged into receiving waters. The mesh number is an indication of the number and size of openings in the screen. The larger the mesh number the greater the number of openings in a square foot of screen.

The advantages of screens are that they are simple and inexpensive to operate. The disadvantages include clogging (especially with oils and grease) which requires self clearing devices or manual removal of solids. A grease trap can be applied to improve efficiency of oily waste streams. There are several different types of screens: flow through, tangential, vibrating, rotary, inclined, and static. Two of the most commonly used screens are the tangential and the rotary screens. The tangential screen is static, but is less prone to clogging than flow through static screens. Removal rates for tangential screens vary from 40-75%. See Figure 8 for a diagram of a tangential screen. Rotary drum screens consist of a horizontal drum which rotates along its long axis. The effluent enters through an opening at one end. Screened wastewater flows outside of the drum while solids are retained inside the drum. The retained solids are washed out from the screen into a collector (Gonzalez 1996). (See Figure 9). Screens are

available in many different types and sizes, from 0.5 inch opening static screens to 200 mesh rotary vibrating screens. The screening media used in seafood processing systems is generally stainless steal with openings varying from 0.7 to 1.5 mm (Gonzalez 1996).

The typical size screens used in seafood processing are around .03 in (30 mesh). Screens can be used in combination, series, or parallel to achieve desired removal efficiencies.

The effectiveness of screens is variable depending on the process and type of screen. Using surimi as an example, vertical screens for removing waste are inadequate.

40 mesh screens are the minimum technology required by the Oregon State DEQ for seafood processors operating under the state's General Permit #900J.

See Table 10 for removal efficiencies of screen systems.

Figure 8. Diagram of an inclined or tangential screen (EPA 1975)

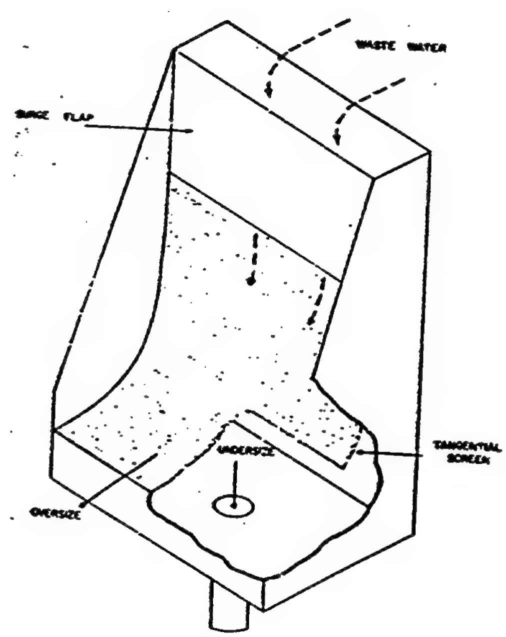


Figure 9. Diagram of a rotary screen (EPA 1975)

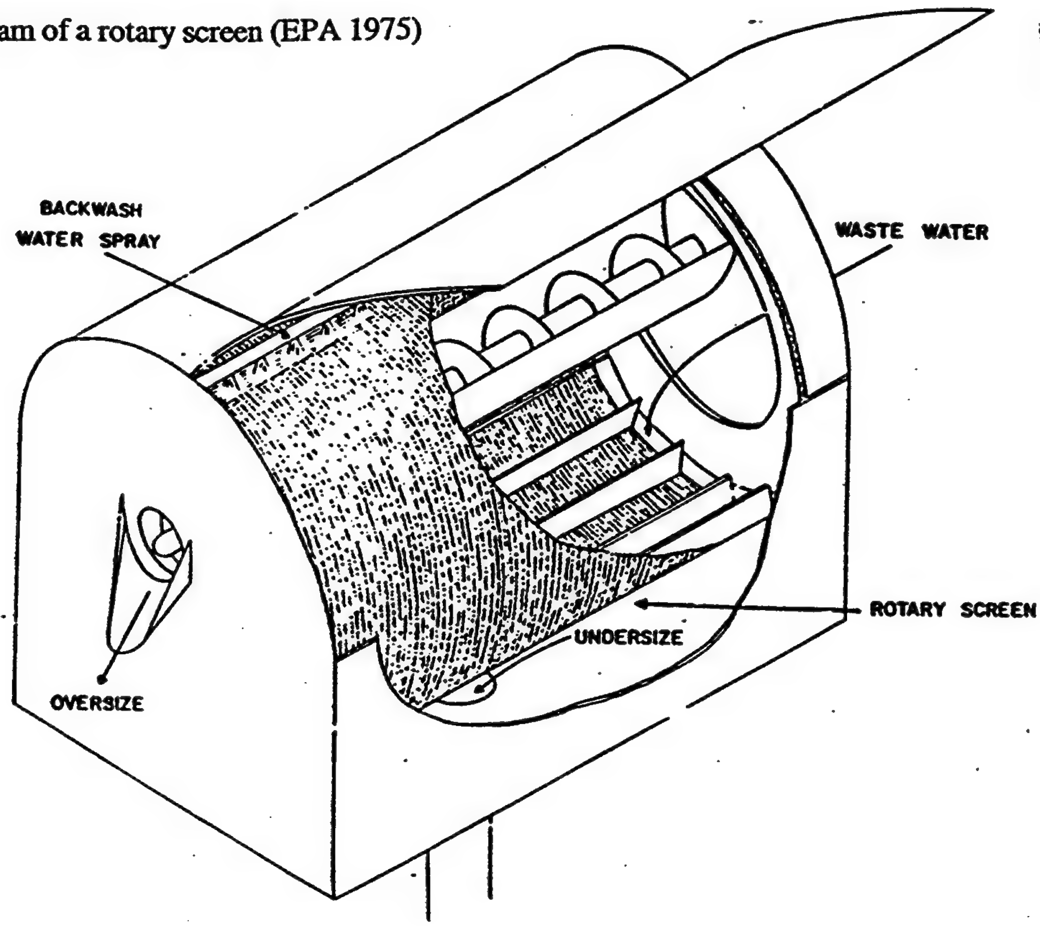


Table 10. Typical Tangential Screen Removal efficiencies (% reduction)

Water Source	Parameter	20 mesh	40 mesh	100 mesh	150 mesh
Salmon canning	TSS	56		35	
Salmon fresh/frozen	TSS	45	56	35	86
	COD			13	36
Bottom fish	TSS	58			
Clams	TSS	45			
Shrimp	TSS	88			
	COD	46			

Source: EPA 1975

ii. Flow equalization/Waste stream segregation -

Flow equalization is used to reduce the short term hydraulic loading on a specific unit, and keep the flow at a constant rate to improve process efficiency. This is usually achieved with holding tanks and pumping equipment. This is an important option for seafood wastewater which is often variable in loading and volumes throughout the season and day.

iii. Sedimentation -

Sedimentation is a physical process used to remove suspended solids from waste water. After screening, it can be used to remove smaller suspended particles which passed through the screen. The different densities between the liquid and solid particles, create a situation where the solid particles will settle and separate from the water over time. This operation can also be used after secondary treatment to separate solids generated in the biological treatment. There are three types of settling which occur: discrete settling, where particles do not interact; flocculant settling in which particles flocculate or coalesce forming larger particles which settle out; and zone settling which occurs when particles adhere together and settle as a blanket. There are two main types of settling basins, the rectangular and the circular clarifier. (See Figure 10 and 11). The tanks vary in size depending on the amount of removal required and the flow. Since sludge will collect at the bottom of these tanks a system for sludge removal will be required. In general, sedimentation basins take up large areas which may not be an option for most seafood processors. An alternative to the traditional clarifiers is the inclined tube separators. (Figure 12) This design combines an inclined screen like device with a clarifier. The concept relies on the idea that smaller particles reach the wall of the screens and will combine with another particle to give one of larger mass and a higher settling rate (Gonzalez 1996).

Figure 10. Diagram of a Circular Clarifier (Metcalf/Eddy 1979)

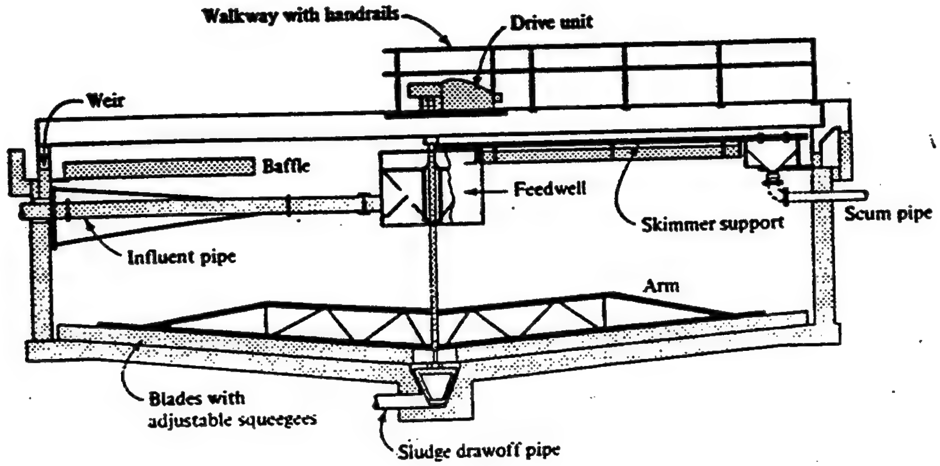


Figure 11. Diagram of a Rectangular Clarifier (Gonzalez 1996)

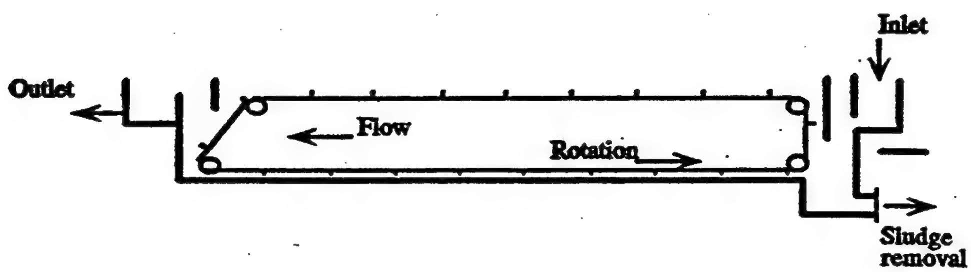
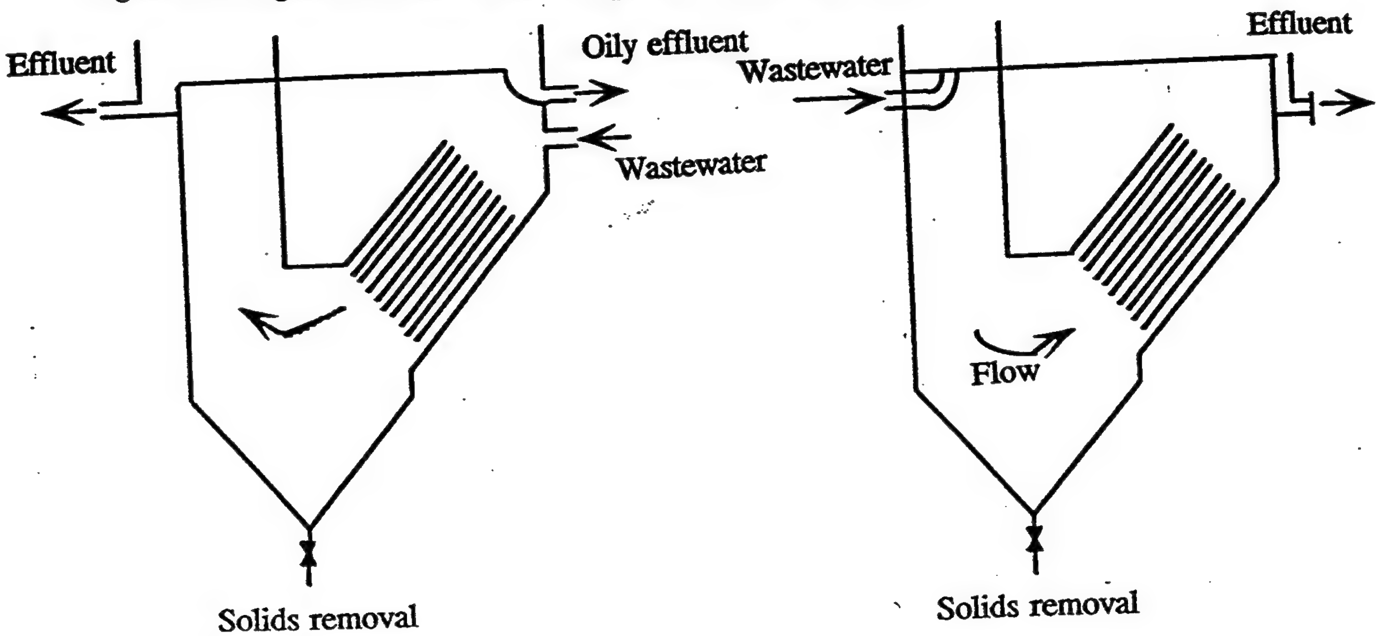


Figure 12. Diagram of Inclined Media Separator (Gonzalez 1996)

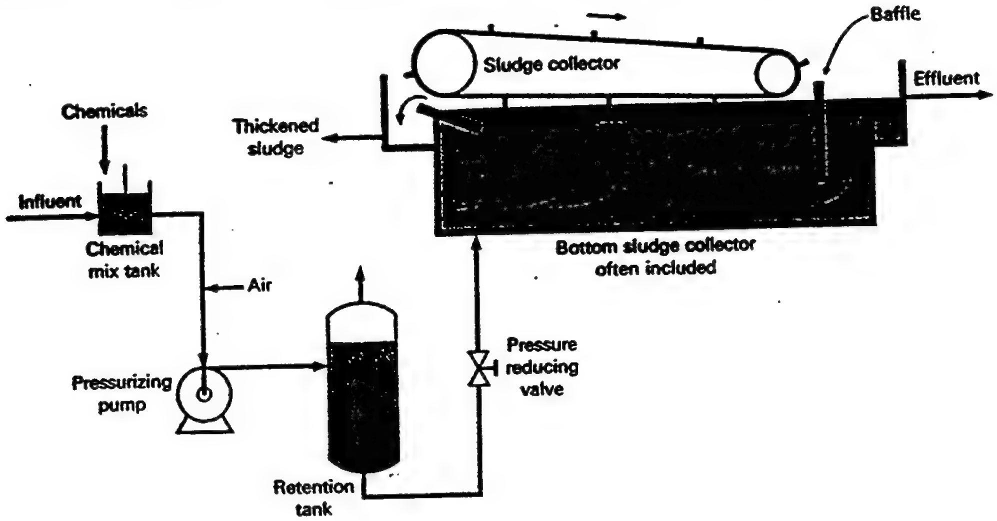


iv. Dissolved Air Flotation Devices -

Dissolved air flotation is a process in which oil, grease, and other suspended matter is removed from the wastewater. It has been successful at removing oils and grease, and is a good option for the treatment of processes which have high oil and grease contents such as surimi and seafood canning operations. The basic process uses tiny air bubbles to remove suspended matter in the waste water stream. The air bubbles latch onto suspended particles, reducing the specific gravity of the particles to less than that of water and the particles float to the surface. These particles are then removed from the water surface by a skimming device to a collection area for removal from the system. The tiny air bubbles are produced when raw wastewater comes into contact with a recycled, clarified effluent which has been pressurized through air injection in a pressurized tank. The release of pressure as the flow enters the clarification vessel causes the air bubbles to form and rise to the surface. To improve removal of solids, flocculating aids (ferric chloride, alum, lime), coagulation aids (anionic polymers), or pH controls can be added. Various combinations of these chemicals have been demonstrated to increase the particles removal efficiency of the dissolved air flotation process.

Dissolved air flotation units usually require prescreening, settling basins, addition of coagulants, and pH control to optimize efficiency. Capital cost as well as operating costs can be high. The sludge produced must be disposed of in a landfill or other option. Additionally, the sludge is high in oil and difficult to dewater. DAF units are effective at removing significant amounts of COD, BOD, TSS, ammonia, nitrogen, total phosphorus, coliforms, and oils from some waste streams. It is a good pretreatment for public sewage to reduce the organic loading and high oils and greases (Carawan 1979).

Figure 13. Diagram of Dissolved Air Flotation System (Metcalf/Eddy 1979)



v. Cyclones -

Cyclones are used to remove small suspended particles from a waste steam and can be applied after the screening of waste water. Centrifugal force is used to separate solids and other forms from the water. Cyclones are usually an economically feasible option in most cases. They have high removal efficiency for particles like scales, and other small particles which have penetrated the screen. Cyclones are relatively small and may be a good option for plants with little area for expansion. One primary downfall of cyclone is the need for maintenance due to mechanical parts.

Table 11. Factors affecting the choice of primary wastewater treatment for seafood processors

Operating Characteristics

System	Recommended use with	Sensitivity to intermittent operations	Degree of skill
Screen	DAF, cyclones, all secondary sedimentation	Small	Minimum
Sedimentation	Biological treatment	Small	Moderate
DAF	Screens	Small	Maximum
Cyclone	Screens	Small	Moderate

Cost Consideration:

System	Land needed	Capital cost	Operating cost
Screen	Minimum	Minimum	Minimum
Sedimentation	Maximum	Moderate	Moderate
DAF	Moderate	Maximum	Maximum
Cyclone	Small/Moderate	Moderate	Moderate

Source: Gonzalez 1996

Primary treatment represents the category of most commonly used wastewater treatment options for seafood processors. Screens have proven to be a reliable low cost method for achieving effluent discharge requirements for most seafood processors. Several of the larger operations which deal with a waste stream high in oils and greases have moved to a system which involves screening of wastewater followed by a dissolved air flotation unit. Sedimentation generally is not a good option due to the space required and the effectiveness in treating seafood processing waste water compared to others options. Cyclones have had limited application in the seafood industry, but may prove to be an option in the future.

b. Secondary Biological Treatment:

In those locations where primary treated effluent is not acceptable for discharge it is possible to use biological, secondary treatment, or land disposal. Systems frequently used for secondary treatment include aeration, aerated lagoons, activated sludge, trickling filters, and land application. These options often require large land or flow areas for treatment. Combining waste waters from several different plants at one central location may provide for an option of this kind and proportion. Most seafood processing wastewater discharge requirements currently are not at the level which require or justify the level of treatment provided by most of these secondary biological treatments as part of in-plant operation. Their use may prove to be an important option in the future. If wastewater is sent to a municipal treatment facilities a biological treatment or combination of biological treatments are typically used in the process of cleaning the wastewater.

Land application of seafood processing wastewater is an option which may prove to be of aid to agricultural crop land.

Biological treatment is designed to remove the non-settable solids and the dissolved organic load from the effluent using microbial populations. The microorganisms degrade the soluble organic matter and convert it to bacterial cells that can be removed by sedimentation of or filtration. One challenge associated with biological treatment is the maintenance of bacterial populations. Biological processes are classified as aerobic or anaerobic which is defined by the organisms which are used in the process. These organisms can either require oxygen (aerobic), grow in the absence of oxygen (anaerobic), or grow in either environment (facultative). Most organisms use the organic matter in the waste water as an energy source. The populations in a biological wastewater treatment facility are made up of many different organisms, which have complex and interrelated relationships. It is important to maintain uniform waste loading and flow for best results and survival of organisms. Biological treatments may require a flow equalization tank to minimize changes in flow or concentration.

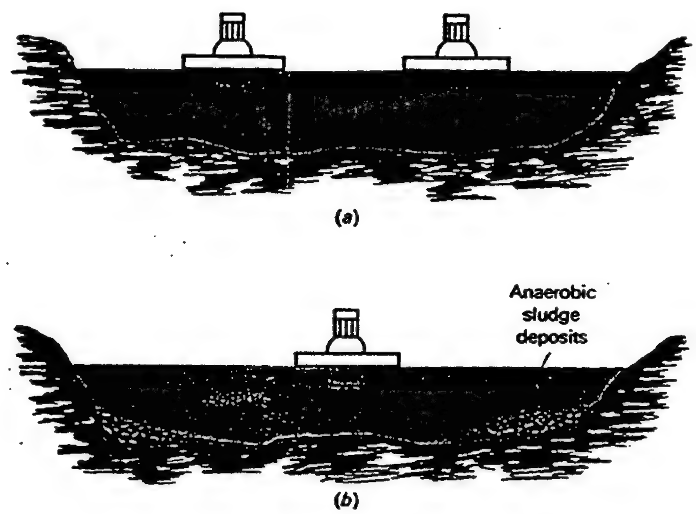
i. Lagoons, Aerated and Facultative -

Waste water is placed in basins, usually excavated from the earth without solids recycling in the system. Aerated lagoons can be used where sufficient land is available. Microorganisms in these ponds remove BOD from waste water aerobically near the surface. In completely mixed lagoons, the concentrations of solids and dissolved oxygen are maintained fairly uniform and there is little settling. In facultative lagoons where solids are allowed to accumulate, anaerobic decomposition takes place near the bottom. Air is applied by floating mechanical aerators or compressors through air diffusers located at the bottom of the ponds. Basins are generally 2.5 to 4.5 feet deep, with a 2 to 10 day retention time. These ponds normally achieve 55 to 90% reduction in BOD (Carawan 1979). Temperature and short circuiting are considerations in design.

Additional ponds can also be used for stabilization and polishing of waste waters after primary and secondary treatments. This type of system has relatively low operations and

maintenance cost, as well as low capital investments. They may be less effective in some areas due to low temperatures. Land availability may restrict their use in other areas.

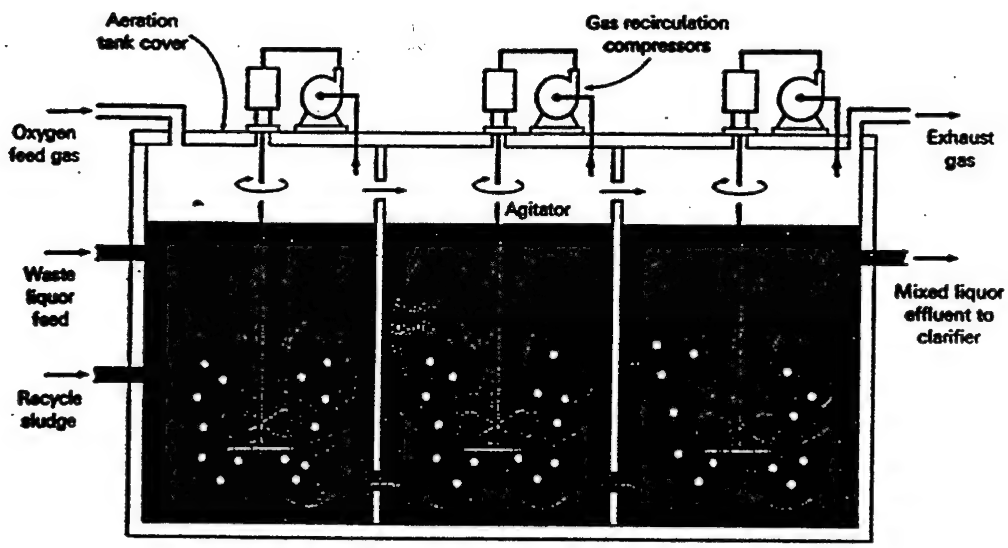
Figure 14. Diagram of aerated lagoons, top - aerobic, bottom - facultative. (Metcalf/Eddy 1979)



ii. Activated Sludge –

In an activated sludge system (Figure 15), a naturally evolving population of organisms suspended in water is contacted and mixed with the waste water in the presence of excess oxygen and nutrients. The microorganisms use organic materials in the wastewater converting them into CO_2 and cellular waste through respiration. A high oxygen concentration is maintained through vigorous mixing. The effluent is then settled to remove solids. A portion of these solids is recycled and excess is sent on to further treatment. In seafood waste application, moderate detention times (1 to 2 days) are required to remove the relatively low strength wastes (Carawan 1979). Primary treatment and flow equalization are often required to allow for optimum operation. BOD and SS removal of 95 - 98% can be achieved (Carawan 1979). Common values for organic removal are 85-95% (Gonzalez 1996). Activated sludge systems can be complex and require high capital investment. In addition, operation, maintenance, and technical support costs are significant. The also require a large amount of area.

Figure 15. Diagram of an activated sludge unit (Metcalf/Eddy 1979)



iii. Trickling filters –

The trickling filter is an attached growth process as compared to a suspended growth seen in activated sludge. Waste water is sprinkled on top of the surface of a packed media with a biological film growing on it. The biological populations degrade the organic contents of the waste water as they come into contact. Organic material grown on the media must be flushed periodically from the surface to maintain aerobic degradation in the system and prevent clogging. Trickling filter units consist of circular tanks or packed towers. Each is filled with packing material with attached growth. The treated waste water is collected at the bottom of the unit. Low temperatures reduce the effectiveness of the process. Trickling filters can be covered to reduce this effect. Typical removal efficiencies for BOD are between 45-70% for single stage filters. Removal efficiencies of up to 90% can be achieved when water is run through the system twice (Gonzalez 1996). Capital costs of trickling filter operations can be high to moderate depending on the design and number of units required. Operation and maintenance costs are relatively low compared to activated sludge.

iv. Rotating Biological Contactor –

Rotating biological contactors(RBC) are also attached growth systems. Biomass is attached to large rotating disks which are rotated at 1-3 rpm through the wastewater. The disks are about 40% immersed in the waste water. The disks are usually made of corrugated rigid plastic material. Organic matter removal efficiencies are similar to trickling fitter units. There is a relatively low power consumption associated with turning the disks which contributes to the operation and maintenance costs. The capital costs are moderate compared to other biological technologies.

Key factors in the selection of treatment method include: area available, ability to operate intermittently, waste water parameters, technical skill is needed, and cost.

Table 12. Factors affecting the choice of biological treatment for seafood processors

Operating Characteristics:

System	Resistance to shock loads of organics or toxins	Sensitivity to intermittent operations	Degree of skill
Lagoons	Maximum	Minimum	Minimum
Trickling Filter	Moderate	Moderate	Moderate
Activated Sludge	Minimum	Maximum	Maximum

Cost Consideration:

System	Land needed	Capital cost	Operating cost
Lagoon	Maximum	Minimum	Minimum
Trickling Filter	Moderate	Moderate	Moderate
Activated Sludge	Minimum	Maximum	Maximum

The considerations for RBC systems are similar to those of trickling filters.

Source: Gonzales 1996

Sludge produced from biological treatments is generally further reduced by anaerobic processes, dewatered and applied to cropland.

v. Land Application –

The application of wastewater to cropland is an options for disposal provided that sufficient land appropriate characteristics are available. There are two main applications, infiltration and overland flow. Treatment of seafood processing waste by each of these processes has been good, 98% removal of pollutant for infiltration and 84% for overland flow systems(Carawan 1979). Consider the following in design: health effects, effects on vegetation, soil, water (ground and surface). Such information as waste water characteristics, climate, soil, geology, topography, land availability, and return flow quality all contribute to the effectiveness of this application and its efficiency. Land applications are effective for the removal of nitrogen, phosphorus, and grease. Irrigation is another applications of seafood wastewater.

Loading rates can be determined by pilot plant testing for each particular location. This will help establish hydraulic and organic loading constraints. There is low capital and low operating cost associated with land application. In some instances there may be a problem with disease producing bacteria (use low pressure distribution to reduce aerosol drift of spray) and unfavorable sodium absorption ratios of the soil, based on soil type. Grasses which are compatible to seafood wastewater include: Bermuda NK-37, Kentucky- 31 Tall Fescue, Jose Wheatgrass, and Blue Panicum (Carawan 1979). A study of land application in Oregon, applied shrimp and crab waste and waste water to agricultural land (Costa 1978). Sea Grant found that shrimp and crab waste can be an effective sources of N and P for some crops. Large applications decrease their efficiency around 18,000 kg/ha. For coastal farmers, no additional of specialized equipment is needed to use this nutrient source.

The high cost of coastal land and the land surrounding the seafood processor may limit land application as a wastewater disposal option. Land application encounters the problems of limited land availability and/or possible transportation cost.

It has been shown that limited application of wastewater to wetlands or constructed wetlands can be done without detrimental effects on the environment (Turner 1976). In some areas this may be a viable alternative to wastewater disposal, but more research is needed in order

to design land treatment systems effectively for seafood wastewater. Seafood processing wastewater; high in nitrogen, phosphorous, oil and grease, trace anions, and metals, may have unique effects on the soil systems, and in can improve the soil quality in most cases (Overcash 1980). Shellfish wastes have high levels of calcium carbonate, which is similar to agricultural lime (Kreag 1973).

c. Chemical treatments:

A variety of chemicals can be added to waste streams before or during processing to manipulate waste water parameters or increase removal efficiencies. Some examples of this are flocculants, pH controls, and disinfectants.

Flocculation / Coagulation is use of chemical additives to improve removal efficiency in operations designed to remove particles such as DAF and settling. The use of polymeric flocculant: polychlorate $Al_2(SO_4)_3$ and heating achieves BOD and COD reduction of 75 to 80% (Krofta 1988) This technology is pH, fish species, temperature, and amount of coagulant dependent.

Disinfection is a treatment used to kill pathogenic organisms before they enter the final effluent stream. This may be an option for seafood processors in areas which are concerned with pathogenic microorganisms in effluent waters. Chlorination, ultraviolet radiation, and ozonation are common method of disinfection.

4. Water Use:

a. Minimization

Modifying waste handling and cleanup practices can provide cost savings in several areas. It is important to keep solid product as solid. When water mixes with seafood, the seafood is broken down into smaller and smaller particles overtime. From a product and waste recovery stand point, it is best to use less water. Smaller particles are harder and more expensive to separate from the waste streams. In a report published by the New England Fisheries

Development Association, Inc. one processor was quoted that as a rule of thumb any dollar spent on dry handling and isolation of solid waste will save five dollars in waste treatment costs (Goldhor and Koppernaes, 1992).

Ways to reduce water use:

Dry clean up:

- Keep viscera and scraps off the floors where water is running during processing
- Allow waste to fall on the floor, but restrict water from flowing over the material. Periodic dry cleanup using shovels, squeegees, brooms, or vacuums can be used to remove these wastes.
- Some capital cost, reduce operational costs.
- Dry cleanup can be used before the "washdown", using water hoses to clean areas during breaks and after processing. The practice of sending these wastes down the drains, excess loading to the next level of treatment. The higher the flow and waste loading the more expensive the treatment.
- Use dry conveyors rather than wet or flume method of transportation where effective.

b. Water conservation:

- High pressure/low volume washers could replace regular washers for cleaning of equipment and floors
- Spring loaded hose nozzles with automatic shut off to reduce wasting water.
- Maintenance and repair of hydraulic systems, to reduce loss of water due to leaks.
- Run water only when needed.
- Avoid unnecessary overflow of equipment
- Avoid using water to transport materials that can be moved effectively by dry conveyors.
- Reusing process water – this option is usually not considered due to the risk of bacteria contamination. Membrane filtration technology is a common treatment option.

- Education of plant personnel of ways to reduce water use is key to minimizing water consumption.

Dry Clean up applied to shrimp processing showed reductions in BOD loading by 24% (Bough 1978).

The techniques used include the following;

- Placing plan to collect breading or dripping batter.
- Squeegee batter from the floor before wet cleanup
- Empty batter tanks in barrels rather than drains
- Use stiff broom to sweep up breading from floor and collect from animal food.
- Collect breading from machines by hand before hosing or air gun use.

Water conservation is our best option for reduction in water use. Industries who routinely monitor their water usage and their waste effluent flows have been able to reduce the in-house uses of water by as much as 50% (Carawan 1979).

c. Water reuse and recycling

Water reuse is the utilization of a process waste one or more times before it leaves the plant. It generally involves taking the effluent from one or more unit processes and using it in the influent of other unit processes. Recycling is the use of water from one unit process to use in that same unit process. The key to water reuse is making sure the water used matches with the requirements of each process. Public Health and sanitation is of major concern in this area. Potential health risk of using renovated wastewater must be evaluated. Reused waters should be free of pathological microorganisms, harmful chemicals, and odor or color causing materials which all may effect public health and or the quality of the final product. Treatment of water between uses can often increase the usefulness of this option. Membrane technology is one option for this treatment. A consequence of additional treatment is additional cost. For some processes which don't involve direct contact with the final product this is a good option. The public health aspect of this option often makes it difficult to implement in all areas.

Water reuse can be adopted for an economic advantage when:

- Insufficient water is available to maintain operation year round.
- By products can be economiccaly recovered from the treatment process.
- Treatment cost of reuse is less than the cost of water and discharge.

Possible steps for proceeding toward water reuse:

- Determine effluent quantities and characteristics, and requirements of plant units.
- Find lowest cost treatment options needed for effluents to reach to secondary users.
- Reduce wastewater volumes - maintain and equipment modifications.
- Study the effects of reuse on existing equipment (Carawan 1979).

A study done in Maryland in 1983 found that wastewater reduction of 20% could be achieved without adversely affecting food product quality. Comprehensive water use and wastewater plans can reduce costs by 25 to 50 percent, reduce BOD by up to 50 percent and reduce TSS by up to 30 percent (Gates 1991). With the high costs of equipment and operation of water treatment whether onsite or off, reducing the amount of water used saves money. Reduction of water through some of the above mentioned techniques can pay significant dividends in plant cost and in reducing the waste disposal situation. Water is no longer free. Water costs money to procure, pump, and dispose of.

V. SOLID WASTE MANAGEMENT

There are two main options for the management of seafood processing solid wastes, disposal or recovery. Seafood wastes are becoming more and more a commodity to be utilized as valuable byproducts. Wastes formerly dumped back into the areas surrounding seafood processors can now be transferred to secondary processors to utilize these proteins and nutrients in everything from fish meal to plant fertilizer. Recovering these wastes also reduces the loading and concentrations of waste water being discharged from seafood plants.

The solid waste management disposal issue is not without residual problems. Waste utilization becomes a problem for seafood processors in remote sites, where byproduct recovery facilities are not close enough to justify transportation costs. The storage of seafood waste is a difficult problem due to odor and rapid decomposition. Wastes must be transported to the secondary processor in a timely manner. Due to the variable nature of the seafood industry and the amount and type of waste produced on seasonal basis, it is difficult to maintain a secondary processing operation economically. Additionally, markets for these products are often variable and unstable. The recovery of byproduct from seafood processing solid wastes is a growing idea and practice. It is in transition to become a more important and stable industry, as markets open and seafood processors are required to find alternatives for the disposal and use of their solid wastes. This is the trend for Oregon seafood processors who send most of their wastes to alternate reclamation facilities. The primary users of seafood waste byproducts in Oregon are listed in Appendix B.

Three broad categories of seafood processors can be identified. First, there are large plants, where alternative uses for solid waste are plentiful, and little problem exists. The second are relatively small plants located in areas of no or inadequate disposal alternatives. The middle ground, presents a wide variety of conditions, where alternatives to waste dumping are variable, and there is the potential for more economical alternative uses for wastes. This middle category encompasses the majority of Oregon's seafood processors. General solutions will not be effective to solve the solid waste management problems.

1. Disposal options:

a. Landfilling

The landfilling of seafood waste involves transporting wastes to a public landfill or privately owned operation. Increased restrictions on landfills have made seafood processing solid waste disposal expensive as compared to the past. The lack of adequate disposal sites and the high rains associated with the Oregon coast create high leachate problems. There is often the problem of insufficient capacity of landfills in remote areas. Hauling cost are often the most expensive part of the operation. Decomposing seafood can cause problems with vectors and odor if not properly covered and managed. Mixing seafood wastes with other solids decreases these problems.

b. The ODF&W Fisheries Enhancement Permit

The Fisheries Enhancement permit program allows seafood processors in Oregon to discharge solid waste into adjacent water ways. There are stipulations on the times and amounts of discharge as well as a particle size restriction. The program is managed by the ODF&W. The Oregon DEQ authorized this program. This permit program was designed to return some of the nutrients back to the system to be utilized by the natural fauna for a positive effect. There have been no negative aspects of this activity reported. Additionally, this program allows for the cheap disposal of seafood wastes for processors.

No complete scientific studies have been done to evaluate the effects of fish discharge on local environment or fish populations. The practice of grinding up seafood waste and dumping it in adjacent water ways is common for remote plants in Alaska. Proper mixing is important to the cycling of this waste in the natural system to avoid build-up and contamination. Verbal reports indicate that when the waste is discharged during the out going tides in appropriate quantity this practice is not a problem. The effects of organic waste discharge are largely the effect of the quantity of material and the rate of flushing from an estuary. (Heald and Odum 1974). "When discharges occur into waters having high tides that produce strong currents and good dispersion,

the resulting dilution of waste causes few changes in parameters such as temperature, turbidity, dissolved oxygen, and benthic deposits. However, where tidal or current conditions result in quiescent shallow bodies of water, bottom deposits and water quality problems can be expected" (Tilsworth 1983).

The future of this permit is uncertain. The effects of this practice need to be better understood in order to determine the fate of this practice in Oregon. More economic uses for fish wastes may make this permit obsolete in the near future.

c. Ocean Dumping

Dumping solid wastes offshore is another method for disposal. Dumping outside of one mile requires a permit from the Federal EPA. Several problems and obstacles exist with ocean dumping. First, the cost of this operation can be relatively high. Primary costs would be in time, energy and labor involved in loading/unloading, and transportation. The feasibility of having out going fishing boats dump waste at sea is not recommended because of the possibility of contamination of the catch. Special barges or fish holds are required, adding significant costs. Waste needs to be shipped frequently to avoid the development of odors. Additionally, there are limited daily quantities of waste which vary from day to day and season to season. Inclement weather could also prevent the disposal of wastes. Environmentalist groups have strongly opposed dumping of wastes at sea, while other groups feel that this method would return to the sea that which was removed. Studies have been done of ocean dumping of seafood waste off the coast of Los Angles and Somoa to assess impacts. No negative effects were found (Soule 1976). Further research may be required to understand the effects of this practice.

2. By-product recovery and utilization:

The optimal approach to solving the waste and pollution problems in the seafood industry is to utilize the raw material fully, rather than waste it and have to treat or dispose of that waste.

According to Dr Roy Carawan of North Carolina State University, "essentially, all fish waste components have desirable nutritional properties" (1979). There are many options for the use of seafood wastes. They depend on the quality and type of byproduct as well as the demands of the market.

Byproduct recovery is and will be very important in the future of seafood processing. In Oregon, we are transitioning from disposal to byproduct recovery.

Oregon has a unique situation in that large amounts of seafood wastes are located in close proximity to a large agricultural center, Willamette Valley. Some have begun to capitalize on this resource, and there seems to be a growing interest in the utilization of this waste to improve both crop and livestock production. Research is being done on the feasibility of different uses for fish based products in agriculture.

Seafood is a highly variable market, dependent quotas and fishing allocations. To build a high capital investment fishmeal, protein hydrolsates, or animal feed plant can be risky. Currently, fish meal is in high demand. According to Ken Hilderbrand, 100,000 ton shore side catch of whiting can be converted into $7.5 million in fish meal at current value (1993). Other products produced from whiting byproducts have even higher values. The waste is there. The management practices and markets of these products are still developing.

a. Deboning

Deboning offers an opportunity to recover additional product. Filleting waste, such as frames, trim wastes, and tail sections can all be deboned to produce minced fish. Fish too small for filleting can also be utilized by deboning. Shellfish can also be "deboned" to recover protein and flavor components. Uses for minced fish include Japanese style sausage, croquettes, patties, chowder, snack dips, and pet foods.

Process:

- Washing
- Dewatering
- Straining
- Chilling

The primary disadvantage of deboning is that it requires 1 or 2, up to 7 times the volume of water for washing and chilling the minced fish (Green 1979).

b. Fish meal (concentrated, high protein animal feed supplement)

The process associated with this product usually requires high capital cost, skilled labor, and an energy source for drying the product. This form of recovery is best when implemented on a large scale, possibly utilizing the waste from several plants in a localized area. There are two main types: Dry reduction and wet reduction. Dry reduction is limited to lean fish. It is a batch process in which fish is cooked, often pressed to remove oils, then dried in one machine. Wet reduction is a continuous process which involves steam cooking the fish, pressing, and then drying. The dry reduction process allows for more flexibility in loading but the wet process yields a less oily product and can handle any fish regardless of oil content. Shrimp and crab can also be utilized this way. The price of fish meal on the international market as well as in the marketing of the product as animal feed is dependent on the protein content. It is important to analyze and report the minimum percent of protein, maximum fats, moisture, fiber, calcium, and phosphorus (WCDF 1983). The oil from which is removed during this process can also be marketed as a feed supplement and or paint ingredient. There are several fish meal plants located at major ports in Oregon and it is the primary product from fish waste. Its market conditions are promising.

c. Protein Hydrolysates

This technology is used to dissolve the fish flesh away from other materials. The protein can be dried and potentially used as fish protein concentrate and animal feed, peptones for microbial growth, or recombined by reactions to form long chain food proteins. There are several methods for producing protein hydrolsates including: natural from separating solids from

"stickwater", enzymatic process from adding autolitic or proteolytic enzymes added to waste products, and chemical process from hot dilute caustic or acidic treatment. The drying process is expensive and the availability of markets is currently small (Green 1979). There is one enzymatic hydrolyzing facility which has operated in Warrenton from 1994 to 1997. This facility is the largest of its kind on the west coast (Hinkamp 1996).

d. Fish Protein Concentrate/Enzymes

This is a food additive used in many countries outside the US as an important source of protein. The common method of making Fish Protein Concentrate(FPC) is isopropyl alcohol extraction, which produces a white, tasteless, odorless, non-spoiling substance. Fish oils, fish solubles, and bone meal can be produced or combined along with FPC to utilize almost all materials (Kreag 1973)

e. Animal Feed/Bait

Sport fisheries operations on the coast use seafood waste as bait. This bait is usually frozen, which consumes energy and freezer storage space depending on the current need. Further research may be needed to develop simpler, inexpensive methods of preserving fish wastes for bait. Commercial aquaculture is another use for fish byproducts. In some large operations or fishing ports canneries exist to package fish wastes to be sold as pet food. In some areas, there may be a market for fresh feed waste such as for mink food and even dairy feed supplements.

f. Oysters/Clam

Shells from clams and oysters are used for producing calcium supplements. Wash water from the final wash of them has been collected condensed and canned as clam broth. Also, the wash has also been condensed and freeze dried to produce a clam flavor additive. Clam and oysters shells can be checked for attached meat, and treated with pasteurized steam to remove this meat and then utilized as an edible product (Green 1979).

g. Chitin

Crabs and shrimp exoskeleton are made up of chitin and calcium carbonate. These constituents can be isolated from waste and used for paper, baby food, stomach antacids, textile finishes, water base paint emulsions, and in film and adhesives. The process for extracting this by-product involves high capital cost, high operating costs, and technical labor. Markets are small and need to be expanded to make this a viable alternative.

h. Liquid fish fertilizer/soil remediation

This idea is being tested by several companies in Oregon. They are marketing liquid fish fertilizer. Liquid seafood wastes have been applied effectively in soil remediation projects for both toxic and non toxic sites.

i. Composting

Fish wastes have been used effectively as additives to composts. The fish adds nitrogen and nutrients beneficial to many crops. Shellfish wastes have high levels of calcium carbonate, which is similar to agricultural lime and can be used in fertilizers. There is a growing market for these type of products especially in the Willamette Valley where soils are acidic. Additionally, combining forest waste products along with seafood wastes in compost is being looked at as a possible marketable product in Northern California (Hilderbrand 1993). This group of products is unique and has the potential for worldwide markets. Organic farmers in the Pacific Northwest are a major consumer of fish composts and fertilizers. These products have a long shelf life as compared to other seafood byproducts.

Table 13 gives suggested byproduct utilization technologies based on the amount of seafood waste produced. Table 14 identifies technologies currently available based on the type of seafood processed.

Table 13. Suggested Technology for Disposal/Recovery of Solid Processing By-products based on Amounts of Waste Produced.

Pounds/day	Most Useful Technology
Less than 500	Ensiling
	Composting
500-10,000	Composting
	Dry Co-Extrusion
	Wet Product Hydrolysis
10,000 - 50,000	Composting
	Condensed Product Hydrolysis
50,000 and up	Condensed Product Hydrolysis
	Dry Product Hydrolysis
	Meal Production

Goldhor et al. 1989.

Table 14. Available By-product recovery options based on species

Waste Type	Technology
Bottomfish	Bait, Fish meal, Protein Hydrolysis, composting
Surimi	Fish meal, Protein Hydrolysis, composting
Shrimp	chitin, composting, crab/shrimp meal
Crab	chitin, composting, crab/shrimp meal
Salmon	Bait, Fish meal, Protein Hydrolysis, composting

Transportation and collection is and will be a major factor in the secondary use and disposal of seafood wastes. Further studies to look at alternatives for reducing these problems would be beneficial since they effect almost every byproduct recovery technique.

VI. ISSUES FACING THE SEAFOOD PROCESSING INDUSTRY

Seafood processing is important to the economy of coastal Oregon and deserves the very best thinking of planners and practitioners. Most seafood processors along the Oregon Coast are relatively small operations and lack access to major sources of corporate capital to add modern equipment or to make dramatic changes in their processing. The area is rich in creativity, however and has demonstrated a willingness to adjust as conditions have dictated. The extent to which seafood processing solid waste materials is being incorporated into commercial compost is a tribute to this openness to change. Composting was not an option a decade ago.

Several issues exist relative to seafood processing waste management that will require extensive discussion over the next decade. The extent to which these issues are resolved to the benefit of all interested parties will determine the growth and profitability of the seafood processing industry. Among the issues are the following:

1. What are the effluent quality requirements for wastewater being discharged into the bays, harbors, rivers and coastal waters of the state? Wastewater discharges coming from an identifiable industrial source are allowable only with a NPDES Permit issued by the Oregon DEQ. These permits specify the concentration, flow and overall quantity of various pollutants that can be discharged. Several parameters are typically specified and a monitoring program is established to prove the discharge within the allowable range. This is not the procedure that has been used with most seafood processors along the Oregon coast. A General Permit was established which has allowed seafood processors to discharge wastewater so long as it is screened through a 40 mesh screen. In addition, the General Permit has a minimal monitoring requirement for which the permitee must submit monthly flow records and indication of the amount of seafood processed. The larger processors and surimi producers have more extensive monitoring requirements.

Discharging seafood processing wastewater after screening has not caused widespread water quality problems nor been identified as a deterrent to recreation in the area. This degree of

wastewater treatment, is significantly less than that required of other wastewater dischargers in the state and less than available technology makes possible. There are good and valid reasons to continue this approach, however there are also reasons to move toward a higher degree of wastewater management.

2. Is it appropriate for seafood processors to reduce their water consumption in response to the growing demand from the coastal tourist and recreation industry? High quality, fresh water is becoming regarded as a limiting resource along the Oregon coast. Unfortunately the peak of the tourist activity and the seafood processing both occur in midsummer when water supplies are most limiting. Changes in seafood processing to conserve water are perceived to represent a significant cost. There may be opportunities to reduce water consumption without increased cost. Certainly, as wastewater treatment demands increase, there will be greater benefits to water conservation. The question arises as to how the cost associated with water use reduction is to be distributed when the benefits do not fall to the same group as the costs.

3. Is the Fisheries Enhancement program which allows seafood processors to grind and discharge solid wastes an appropriate waste utilization scheme that benefits the coastal marine environment or is it a low cost waste disposal scheme that damages the water resource? Inland food processors would not be allowed to discharge a highly putressible wastewater into nearby receiving streams because of the water quality damage that would result. Currently there is no convincing evidence that the program enhances the fishery nor is there convincing evidence that it is creating water quality problems. A monitoring program would seem appropriate to evaluate the benefits and adverse impacts of this practice.

An alternate view is that the grinding and dumping program is transitional and when the market for the secondary products become fully established, seafood processing solid waste will be too valuable to discharge to streams, bays or other natural water courses. Under this view,

research and development efforts that support secondary processing, support water quality improvement by reducing the economic incentive to discharge seafood solids.

4. The General Permit Program 900J has expired and will be evaluated for possible revision and continuation within the next year. There appears to be a shortage of monitoring data that would guide the decision as to whether the current permit program is adequately protecting the resource. Without those data it will be difficult to provide compelling logic to either change or preserve the existing program. Screening devices are notorious in their difficulty of operation and maintenance. Current monitoring programs do not identify plugging problems that promote bypassing nor do they adequately reward careful and conscientious operation.

5. Technologies exist to achieve a variety of wastewater discharge qualities. All of these technologies have costs greater than the current screening requirement. Increased treatment requirements would seem most appropriately based on the need to achieve an improved downstream water quality or to reduce the pollutional impact of current practices. It is difficult to make this judgment with the data currently available.

Secondary industries based on the processing of seafood processing by-products are developing along the Oregon Coast. Many of these are fragile operations that will require ongoing nurturing if they are to prosper. Their success is important to the environmental quality of the region in that they provide highly desirable waste utilization, thereby removing a significant component of the wastewater scheme. The future of these secondary processing operations will require support. Each has particular wastewater disposal and odor control issues.

VII. EXTENSION RESPONSE

The coastal seafood processing industry is an important part of the economic base of the communities in which it operates. These industries although small by some standards are important employers. They have particular problems during these times in which environmental protection guidelines are uncertain in all aspects except that they are changing. The seafood processors typically operate without an adequate land base upon which to locate wastewater treatment facilities. They are frequently in communities for which odor control is important. Finally, they generally do not have sufficient in-house expertise to guide their wastewater management decisions.

The opportunity for extension is to provide the information needed by managers of seafood processing plants as they cope with changing regulations and their need to comply with more complex monitoring requirements. It is also important that in responding to this opportunity, the Extension Service's role be one of assisting the processors to achieve the required environmental protection and not one of imposing additional burdens on the industry.

More specifically, the following activities are suggested for the OSU Extension Service at this point in time.

1. Increase interaction with the industrial association serving the seafood processors. There are several factors which suggest the processors will look to Seafood Processing Organizations such of the West Coast Seafood Association and Extension for guidance and leadership. Extension personnel should be highly available to the individuals and the association for educational programs relating to waste management.

2. Maintain competence in seafood processing wastewater treatment technologies. Both the industries and the regulatory community are entering a process in which both are short on technically trained personnel with experience in the management/treatment of seafood processing

waste. Extension can contribute to more cost effective regulations and treatment by providing an accurate description of alternatives available when those questions arise.

3. The University is the repository of extensive water quality expertise that has come from serving the variety of water quality issues for which Oregon is already well-known. This expertise needs to be made available to both the industry and the regulatory agencies as new guidelines are promulgated and revised permit programs designed. Particularly important is the matter of monitoring strategies. Previous monitoring efforts are regarded as providing little guidance in making current decisions. In the future, it is important to collect monitoring data that will be helpful in making future decisions.

4. Timing of Extension efforts is likely to be critically important. There is a need for several short introductory publications concerning operation of screens to remove seafood solids, composting of seafood processing solid wastes, regulations concerning the discharge of wastewater to Oregon streams and estuaries, tips for reducing water consumption, dissolved air flotation devices, design of alternate solid separation devices, and other topics as interest evolves. The appropriate time for the release of these publications is when they are being sought. By working with the industrial association(s) it should be possible to be responsive.

5. There are similarities among the four Pacific coast states and their need for educational programs related to seafood processing waste treatment. Having a regional extension engineer will be helpful but may not prove adequate. Administrators and agents will need to remain alert to new possibilities for educational services and for cooperative means to deliver those services.

VIII. CONCLUSIONS

Seafood processing is an important component of the Oregon Coastal economy. Due to changes in water quality interests in Oregon, waste and wastewater management, treatment and disposal practices of the past, are not likely to survive over the next decade. Assuming both of these observations to be at least partially true, several conclusions begin to arise.

1. New technology makes it possible to more effectively utilize previously wasted components of the harvested seafood. The development of fishmeal recovery plants and composting operations represent examples of industries that were impossible a decade ago. The extent to which the market supports these developments will have a significant impact on the future of seafood processing.

2. New technology makes it possible to more effectively treat liquid waste to a higher quality. As in other fields, the extent to which wastewater must be treated under regulatory programs is a balance between the cost of pollution abatement and the adverse impact of wastewater discharge. It is unclear whether waste treatment beyond that currently being provided along the Oregon coast would have beneficial impacts.

3. The current monitoring programs do not provide sufficient information to evaluate current and future wastewater treatment alternatives. Whether as part of the regulatory scheme or independently, there is a need for more definitive data to evaluate current practices and proposed alternatives.

4. Important decisions concerning wastewater treatment will be made in the next two years which will impact the future of Oregon coastal seafood processors. There is an opportunity for Oregon State University and the Extension Program to assist the seafood processing industry with timely educational programs. It is important that any extension program be designed and

perceived as being in support of the industry and its efforts to protect and enhance environmental quality. The Extension Service also has an opportunity to serve the regulatory agency by providing monitoring and treatment expertise. It must be absolutely clear, however, that the University and Extension Service have no regulatory responsibilities nor do they attempt to protect industrial clientele who may be involved in water polluting practices.

If the Extension Service is to meet this demand, it must have the technical competence to speak reliably to both its agency and its industrial clientele. Informative publications must be available along with a strong scientific presence to support rational improvement in the environmental quality of the coastal communities while preserving their diverse economic bases.

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X. APPENDICES

A. List of Oregon seafood processors

B. List of seafood byproduct producers

C. NPDES General Permit #900J

D. NPDES Individual Permit #101214

E. ODF&W Fisheries Enhancement Permit

F. Monitoring data collected from ODEQ for seafood processor in Oregon under the 900J permit.

G. List of Abbreviations

APPENDIX A. Seafood Processors in Oregon (1997). Based upon data available in DEQ office in Portland, Salem, and Coos Bay.

Astoria Dock Company	Astoria
Point Adams Packing Co	Hammond
Crystal Ocean Seafood, Inc	Astoria
Hoy Brothers Fish and Crab Co., Inc.	Garibaldi
Kujala, Norman F. DBA	Warrenton
Ocean Foods of Astoria, Inc	Astoria
Pacific Coast Seafood Company	Warreneton
Smith's Pacific Shrimp Company	Garibaldi
Warrenton Deep Sea Inc.	Warrenton
Pearl Point. Wittwer, Mark DBA	Tillamook
Bandon Bay Fisheries Inc.	Bandon
Chetco Seafood Co	Brookings
Hallmark Fisheries	Charleston
Ocean Beauty of Charleston	Charleston
Pacific Coast Seafoods	Charleston
Seahawk Seafood	Charleston
Eureka Fisheries, Inc.	Coos Bay
International C-Food Market	Florence
Eureka Fisheries, Inc.	Harbor
Depoe Bay Fish Co.	Newport
Ocean Beauty of Newport	Newport
Pacific Shrimp Co	Newport
Pacific Whiting Producers	Newport
Point Adams Packing Co	Newport
Tyson Foods (Arctic Alaska)	Newport
Kiwanda Fish Co	Pacific City
Pacific City Seafood	Pacific City
Bell Bouy Crab Co	Seaside
Netarts Seafood Co	Tillamook
Oregon Ocean Seafoods, Inc	Warrenton
Sportmen's Cannery	Winchester

APPENDIX B. List of Secondary Producers

(Secondary Processors and users of whiting by-products)

Advanced Hydrolysing Systems, Inc
    Astoria, OR
Bioproducts Inc
    Warrenton, OR
Thorpe Valley Farms
    Noti, OR
Agri-Mulch/Biomass One
    White City, OR
Hambro Forest Products
    Cresent City, CA
Eco-Nutreints
    Cresent City, CA
H & H Ecosystems
    Nth Bonneville, WA
Ocean Protiens Inc
    Charleston, OR
Arctic Alaska Fishmeal Plant
    Newport, OR
Fair Line Marine, Inc
    Newport, OR
Eco-Sound Products, Inc.
    Seattle, WA

APPENDIX C. Oregon Department of Environmental Quality NPDES General Permit #900J

COPY

Permit Number: 0900-J
Expiration Date: 12-31-96

GENERAL PERMIT

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

WASTE DISCHARGE PERMIT

Department of Environmental Quality
811 Southwest Sixth Avenue, Portland, OR 97204
Telephone: (503) 229-5696

Issued pursuant to ORS 468.740 and The Federal Clean Water Act

ISSUED TO:

All Owners or Operators of Facilities Discharging Pollutants Covered by this permit.

SOURCES COVERED BY THIS PERMIT:

Treated discharges of process wastewater from seafood processing facilities and storm water discharges.

Lydia R. Taylor
Lydia R. Taylor, Administrator

FEB 05 1992
Date

PERMITTED ACTIVITIES

Until this permit expires or is modified or revoked, the permittee is authorized to discharge to waters of the state, contaminated storm water and treated process wastewaters, only from the authorized discharge point or points established in Schedule A and only in conformance with all the requirements, limitations, and conditions as set forth in the attached schedules as follows:

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Schedule C - Compliance Conditions and Schedules	-
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Each other direct and indirect waste discharge to public waters is prohibited unless covered by another NPDES permit.

This permit does not relieve the permittee from responsibility for compliance with any other applicable federal, state, or local law, rule, standard, ordinance, order, judgment, or decree.

SCHEDULE A

Minimum Waste Water Treatment Requirements for Facilities Covered by This General Permit

1. All process waste water shall pass through a screen at least as fine as 40 mesh (or equivalent control) prior to discharge. The Biochemical Oxygen Demand (BOD_5), Total Suspended Solids (TSS), and Oil and Grease (O & G) discharged shall not exceed the quantities calculated from Table A, below. Before a method of control other than 40 mesh screening is to be used, in order to achieve the discharge limitations, written approval must be received from the Department.

TABLE A[a]

All Existing Sources (Except for those started after July 30, 1975.)

Species	TSS		Oil & Grease	
	Monthly Avg.	Daily Max.	Monthly Avg.	Daily Max.
Crab	2.7	8.1	.61	1.8
Shrimp[b]	54.0	160.0	42.0	126.0
Salmon (Hand Butchered)	1.6	2.6	.19	.3
Salmon (Mechanized)	26.0	44.0	11.0	29.0
Bottom Fish (Mechanized)	12.0	22.0	3.9	9.9
Bottom Fish (Conventional)[c]	2.0	3.6	.55	1.0
Clam (Hand Shucked)[d]	18.0	59.0	.23	.6
Clam (Mechanized)	15.0	90.0	.97	4.2
Oyster(Hand Shucked)[e]	38.0	47.0	1.8	2.4
Scallop	1.4	6.0	.24	7.7

All New Sources (Those started after July 30, 1975.)

Species	BOD_5		TSS		Oil & Grease	
	Monthly Avg.	Daily Max	Monthly Avg.	Daily Max.	Monthly Avg.	Daily Max.
Crab	4.1	10.0	0.69	1.70	0.10	0.25
Shrimp	62.0	155.0	15.0	38.0	5.7	14.0
Salmon (Hand Butch)	1.7	2.7	0.42	0.70	0.026	0.045
Salmon (Mechanized)	38.0	62.0	7.6	13.0	1.5	4.2
Bottom Fish (Mech.)	7.5	13.0	2.9	5.3	0.47	1.2
Bottom Fish (Conv.)	0.71	1.2	0.73	1.5	0.042	0.077
Clam (Hand Shucked)	--	--	17.0	55.0	0.21	0.56
Clam (Mechanized)	5.7	15.0	4.4	26.0	0.092	0.4
Oyster(Hand Shucked)	--	--	36.0	45.0	1.7	2.2
Scallop	--	--	1.4	5.7	0.23	7.3
Fish Meal	3.8	6.7	1.5	3.7	0.76	1.4
Tuna	8.1	20.0	3.0	7.5	0.76	1.9
Surimi[f]	--	--	--	--	--	--
Other[g]	--	--	--	--	--	--

pH -The pH of all process wastewater discharged shall be between 6 & 9

[a] These discharge limitation values represent the pounds of pollutant discharged per 1,000 pounds of raw product processed during the period.

EXAMPLE: If the average amount of shrimp processed during September was 10,000 pounds per day, the allowable discharge of TSS for September would be (10 x 54) 540 pounds per day average with a maximum of (10 x 160) 1,600 pounds per day.

[b] These limits apply only to facilities where more than 2,000 lbs of shrimp are processed on any day during the year.

[c] These limits apply only to facilities where more than 4,000 lbs of bottom fish are processed on any day during the year.

[d] These limits apply only to facilities where more than 4,000 lbs of clams are shucked on any day during the year.

[e] These limits apply only to facilities where more than 1,000 lbs of oysters are shucked on any day during the year.

[f] There are no federal effluent guidelines for surimi. The Department is in the process of collecting data from which effluent limitations can be developed by Best Professional Judgement. Once effluent limitations have been developed, the permit may be reopened and the limitations added. Until effluent limitations are specified, the permittee shall be considered in compliance with this permit provided all process wastewater is screened through fine mesh screens (at least as fine as 40 mesh). Wastewater from the dehydration process will be monitored to determine what benefits will be realized through reducing the pollutants by adding a decanting or other method of treatment and/or disposal. If such a treatment system is implemented, all or a portion of the recovered material will be added back to the product, if practicable. If, because of the fish species being processed, return of the recovered product to the process is not practicable, another method of treatment and/or disposal may be utilized upon written approval of the Department.

[g] There are other possible seafood processing activities, such as sea urchin processing, which do not have specifically adopted effluent limitations guidelines. Until specific effluent limitations are adopted, the facilities will be considered in compliance provided they follow good housekeeping procedures and all wastewater is screened through 40 mesh screens or equivalent.

2. Storm water may be discharged to waters of the state without treatment, provided that all areas of the plant site where seafood scraps are likely to be spilled or otherwise accumulate on the ground are swept of any seafood waste accumulations at least at the end of each shift. This does not include fish scales and slime. As an alternative to sweeping, the storm drainage from any area may be collected and screened with 40 mesh or finer screens.

3. Notwithstanding the water treatment requirements established by this permit, no wastes shall be discharged and no activities shall be conducted which will violate Water Quality Standards as adopted in OAR Chapter 340 Division 41 except in the following defined mixing zone:

   The allowable mixing zone shall not extend beyond a radius of 100 feet from the point of discharge.

4. All screenings, sweepings, and other solid waste must be utilized or disposed of in a manner approved by the Department. By-product recovery and waste utilization shall receive primary consideration.

5. All sanitary waste shall be discharged to the municipal sewer or to an approved on-site system where no municipal sewer is available.

6. Some facilities are participating in a fisheries enhancement project of the Oregon Department of Fish and Wildlife for the disposal of waste solids. Under no conditions shall the screening or other approved treatment system employed to meet the effluent limitations of this permit be bypassed as part of that project. The necessary screens or equivalent treatment must be in use at all times. If seafood waste solids are discharged back to waters of the state by approval of the Oregon Department of Fish and Wildlife, they shall be discharged in accordance with the permit issued by that Department. Any violation of the terms of that permit will be considered a violation of this permit.

SCHEDULE B

Minimum Monitoring and Reporting Requirements
(During months that processing occurs)

Parameter	Frequency
All categories processed:	
Raw Product - (pounds of each species)	Daily average for month
Waste Solids Generated - (pounds)	Total per month
Waste Solids Disposed - (pounds)	Amount and location
Inspection of Screens	Daily
Screening Failures	As they occur
Total Suspended Solids (TSS) - mg/l	Monthly Composite*
Oil and Grease mg/l	Monthly Grab*
Wastewater Flow (million gallons per day)	Average daily
Fish meal or tuna:	
Biochemical Oxygen Demand (BOD_5)	Monthly composite**
Total Suspended Solids (TSS)	Monthly composite**
Oil & Grease	Monthly grab**
Surimi (Dehydration wastewater and final effluent):	
Biochemical Oxygen Demand (BOD_5)	Weekly Composite**
Total Suspended Solids (TSS)	Weekly Composite**
Oil & Grease	Weekly Composite**

Reporting Procedures

Monitoring results shall be reported on approved forms. The reporting period is the calendar month. Reports must be submitted to the Department by the 15th day of the following month.

* Where all wastewater is screened through fine screens (40 mesh or finer), the analysis for TSS, and Oil & Grease is not required for products other than fish meal, tuna, and surimi. Where an alternate method of wastewater treatment is employed, the Department may waive the requirement for TSS and oil & grease sampling once the permittee has demonstrated to the Department's satisfaction that effluent limits are consistently achieved. Any waiver by the Department must be in writing.

** After at least two years monitoring at the above frequency, the Department may reduce the frequency of monitoring for fish meal and tuna, provided that compliance has been demonstrated with the treatment technology employed. After effluent limitations have been established and compliance demonstrated, the Department may reduce the frequency of monitoring for surimi.

GENERAL CONDITIONS

SECTION A. STANDARD CONDITIONS

1. Duty to Comply

The permittee must comply with all conditions of this permit. Any permit noncompliance constitutes a violation of the Clean Water Act and is grounds for enforcement action; for permit termination; revocation and re-issuance, or modification; or for denial of a permit renewal application.

2. Penalties for Violations of Permit Conditions

Oregon Law (ORS 468.990) classifies a willful or negligent violation of the terms of a permit or failure to get a permit as a misdemeanor and a person convicted thereof shall be punishable by a fine of not more than $25,000 or by imprisonment for not more than one year, or by both. Each day of violation constitutes a separate offense.

In addition to the criminal penalties specified above, Oregon Law (ORS 468.140) also allows the Director to impose civil penalties up to $10,000 per day for violation of the terms or conditions of a permit.

3. Duty to Mitigate

The permittee shall take all reasonable steps to minimize or correct any adverse impact on the environment and human health resulting from noncompliance with this permit, including such accelerated or additional monitoring as necessary to determine the nature and impact of the noncomplying discharge.

4. Individual NPDES Permit Required

Whenever a facility expansion, production increase, or process modification is anticipated which will result in a change in the character of pollutants to be discharged or which will result in a new or increased discharge that will exceed the conditions of this permit, an NPDES application must be submitted together with the necessary reports, plans, and specifications for the proposed changes. No change shall be made until plans have been approved and an individual NPDES permit has been issued.

5. Permit Actions

The Department of Environmental Quality (Department) may revoke a general permit as it applies to any person and require such person to apply for and obtain an individual NPDES permit if:

a. The covered source or activity is a significant contributor of pollution or creates other environmental problems;

b. The permittee is not in compliance with the terms and conditions of this general permit; or

c. Conditions or standards have changed so that the source or activity no longer qualifies for a general permit.

6. <u>General Permit Coverage</u>

a. Any permittee not wishing to be covered or limited by this general permit may make application for an individual NPDES permit in accordance with NPDES procedures in OAR 340-45-030.

b. This general permit does not cover activities or discharges covered by an individual NPDES permit until the individual permit has expired or been cancelled. Any person conducting an activity covered by an individual permit but which could be covered by this general permit may request that the individual permit be cancelled.

c. All persons desiring to be covered by this general permit must register with the Department. This can be done by submitting an application provided by the Department along with applicable fees and a Land Use Compatibility Statement to:

Department of Environmental Quality
Water Quality Division
811 SW Sixth Avenue
Portland, OR 97204

7. <u>Toxic Pollutants</u>

The permittee shall comply with effluent standards or prohibitions established under Section 307(a) of the Clean Water Act for toxic pollutants within the time provided in the regulations that establish those standards or prohibitions, even if the permit has not yet been modified to incorporate the requirement.

8. <u>Property Rights</u>

The issuance of this permit does not convey any property rights of any sort, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of federal, state or local laws or regulations.

SECTION B. OPERATION AND MAINTENANCE OF POLLUTION CONTROLS

1. Proper Operation and Maintenance

The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the permittee to achieve compliance with the conditions of this permit. Proper operation and maintenance includes effective performance, adequate funding, adequate operator staffing and training, and adequate laboratory and process controls, including appropriate quality assurance procedures. This provision requires the operation of back-up or auxiliary facilities or similar systems only when necessary to achieve compliance with the conditions of the permit.

2. Duty to Halt or Reduce Activity

Upon reduction, loss, or failure of the treatment facility, the permittee shall, to the extent necessary to maintain compliance with its permit, control production or all discharges or both until the facility is restored or an alternative method of treatment is provided. This requirement applies, for example, when the primary source of power of the treatment facility fails or is reduced or lost. It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

3. Bypass of Treatment Facilities

a. Definitions

(1) "Bypass" means the intentional diversion of waste streams from any portion of a treatment facility.

(2) "Severe property damage" means substantial physical damage to property, damage to the treatment facilities which causes them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.

b. Bypass not exceeding limitations.

The permittee may allow any bypass to occur which does not cause effluent limitations to be exceeded, but only if it also is for essential maintenance to assure efficient operation. These bypasses are not subject to the provisions of paragraphs c. and d. of this section.

c. Notice

(1) Anticipated bypass. If the permittee knows in advance of the need for a bypass, it shall submit prior notice, if possible at least ten days before the date of the bypass.

(2) Unanticipated bypass. The permittee shall submit notice of an unanticipated bypass as required in Section D, Paragraph D-5 (24-hour notice).

d. Prohibition of bypass.

(1) Bypass is prohibited and the Department may take enforcement action against a permittee for bypass, unless:

(a) Bypass was unavoidable to prevent loss of life, personal injury, or severe property damage;

(b) There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if the permittee could have installed adequate backup equipment to prevent a bypass which occurred during normal periods of equipment downtime or preventative maintenance; and

(c) The permittee submitted notices as required under paragraph c of this section.

(2) The Department may approve an anticipated bypass, after considering its adverse effects, if the Department determines that it will meet the three conditions listed above in paragraph d(1) of this section.

4. <u>Removed Substances</u>

Solids, sludges, or other pollutants removed in the course of treatment of control of wastewaters shall be disposed of in a manner such as to prevent any pollutant from such materials from entering public waters.

SECTION C. MONITORING AND RECORDS

1. Representative Sampling

Sampling and measurements taken as required herein shall be representative of the volume and nature of the monitored discharge. All samples shall be taken at the monitoring points specified in this permit and shall be taken, unless otherwise specified, before the effluent joins or is diluted by any other waste stream, body of water, or substance. Monitoring points shall not be changed without notification to and the approval of the Director.

2. Flow Measurements

Appropriate flow measurement devices and methods consistent with accepted scientific practices shall be selected and used to insure the accuracy and reliability of measurements of the volume of monitored discharges. The devices shall be installed, calibrated and maintained to insure that the accuracy of the measurements is consistent with the accepted capability of that type of device. Devices selected shall be capable of measuring flows with a maximum deviation of less than ± 10% from true discharge rates throughout the range of expected discharge volumes.

3. Monitoring Procedures

Monitoring must be conducted according to test procedures approved under 40 CFR Part 136, unless other test procedures have been specified in this permit.

4. Penalties of Tampering

The Clean Water Act provides that any person who falsifies, tampers with, or knowingly renders inaccurate, any monitoring device or method required to be maintained under this permit shall, upon conviction, be punished by a fine of not more than $10,000 per violation, or by imprisonment for not more than 6 months per violation, or by both.

5. Reporting of Monitoring Results

Monitoring results shall be summarized each month on a Discharge Monitoring Report form approved by the Department. The reports shall be submitted monthly and are to be postmarked by the 15th day of the following month unless specifically approved otherwise in Schedule B of this permit.

6. Additional Monitoring by the Permittee

If the permittee monitors any pollutant more frequently than required by this permit, using test procedures approved under 40 CFR 136 or as specified in this permit, the results of this monitoring shall be included in the calculation and reporting of the data submitted in the DMR. Such increased frequency shall also be indicated.

7. Averaging of Measurements

Calculations for all limitations which require averaging of measurements shall utilize an arithmetic mean, except for coliform and fecal coliform bacteria which shall be averaged based on a geometric or log mean.

8. Retention of Records

The permittee shall retain records of all monitoring information, including all calibration and maintenance records of all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by this permit, and records of all data used to complete the application for this permit, for a period of at least 3 years from the date of the sample, measurement, or report of application. This period may be extended by request of the Director at any time.

9. Records Contents

Records of monitoring information shall include:

a. The date, exact place, time and methods of sampling or measurements;

b. The individual(s) who performed the sampling or measurements;

c. The date(s) analyses were performed;

d. The individual(s) who performed the analyses;

e. The analytical techniques or methods used; and

f. The results of such analyses.

10. Inspection and Entry

The permittee shall allow an authorized representative of the Department, upon the presentation of credentials and other documents as may be required by law, to:

a. Enter upon the permittee's premises where a regulated facility or activity is located or conducted, or where records must be kept under the conditions of this permit;

b. Have access to and copy, at reasonable times, any records that must be kept under the conditions of this permit;

c. Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this permit, and

d. Sample or monitor at reasonable times, for the purpose of assuring permit compliance or as otherwise authorized by the Clean Water Act, any substances or parameters at any location.

SECTION D. REPORTING REQUIREMENTS

1. Planned Changes

The permittee shall give notice to the Department as soon as possible of any planned physical alterations or additions to the permitted facility.

2. Anticipated Noncompliance

The permittee shall give advance notice to the Department of any planned changes in the permitted facility or activity which may result in noncompliance with permit requirements.

3. Transfers

This permit may be transferred to a new permittee provided the transferee acquires a property interest in the permitted activity and agrees in writing to fully comply with all the terms and conditions of the permit and the rules of the Commission. No permit shall be transferred to a third party without prior written approval from the Department.

4. Compliance Schedule

Reports of compliance or noncompliance with, or any progress reports on interim and final requirements contained in any compliance schedule of this permit shall be submitted no later than 14 days following each schedule date. Any reports of noncompliance shall include the cause of noncompliance, any remedial actions taken, and the probability of meeting the next scheduled requirements.

5. Twenty-Four Hour Reporting

The permittee shall report any noncompliance which may endanger health or the environment. Any information shall be provided orally (by telephone) within 24 hours from the time the permittee becomes aware of the circumstances. A written submission shall also be provided within 5 days of the time the permittee becomes aware of the circumstances. The written submission shall contain:

a. A description of the noncompliance and its cause;

b. The period of noncompliance, including exact dates and times;

c. The estimated time noncompliance is expected to continue if it has not been corrected; and

d. Steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance.

The Department may waive the written report on a case-by-case basis if the oral report has been received within 24 hours.

The following shall be included as information which must be reported within 24 hours:

a. Any unanticipated bypass which exceeds any effluent limitation in the permit.

b. Any upset which exceeds any effluent limitation in the permit.

6. <u>Other Noncompliance</u>

The permittee shall report all instances of noncompliance not reported under Section D, Paragraphs D-4 and D-5, at the time monitoring reports are submitted unless required otherwise in Schedule B of this permit. The reports shall contain the information listed in Paragraph D-5.

7. <u>Duty to Provide Information</u>

The permittee shall furnish to the Department, within a reasonable time, any information which the Department may request to determine whether cause exists for revoking coverage by this permit, or to determine compliance with this permit. The permittee shall also furnish to the Director, upon request, copies of records required to be kept by this permit.

Other Information: When the permittee becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or any report to the Department, it shall promptly submit such facts or information.

8. <u>Signatory Requirements</u>

All applications, reports or information submitted to the Department shall be signed and certified in accordance with 40 CFR 122.61.

9. <u>Falsification of Reports</u>

The Clean Water Act provides that any person who knowingly makes any false statement, representation, or certification in any record or other document submitted or required to be maintained under this permit, including monitoring reports or reports of compliance or noncompliance shall, upon conviction be punished by a fine of not more than $10,000 per violation, or by imprisonment for not more than six months per violation, or by both.

SECTION E. DEFINITIONS AND ACRONYMS

1. BOD_5 means five-day biochemical oxygen demand.

2. TSS means total suspended solids (non-filterable residue).

3. mg/l means milligrams per liter.

4. kg means kilograms.

5. m^3/d means cubic meters per day.

4. MGD means million gallons per day.

5. Composite sample means a combination of samples collected, generally at equal intervals over a 24-hour period, and apportioned according to the volume of the flow at the time of the sampling.

6. FC means fecal coliform bacteria.